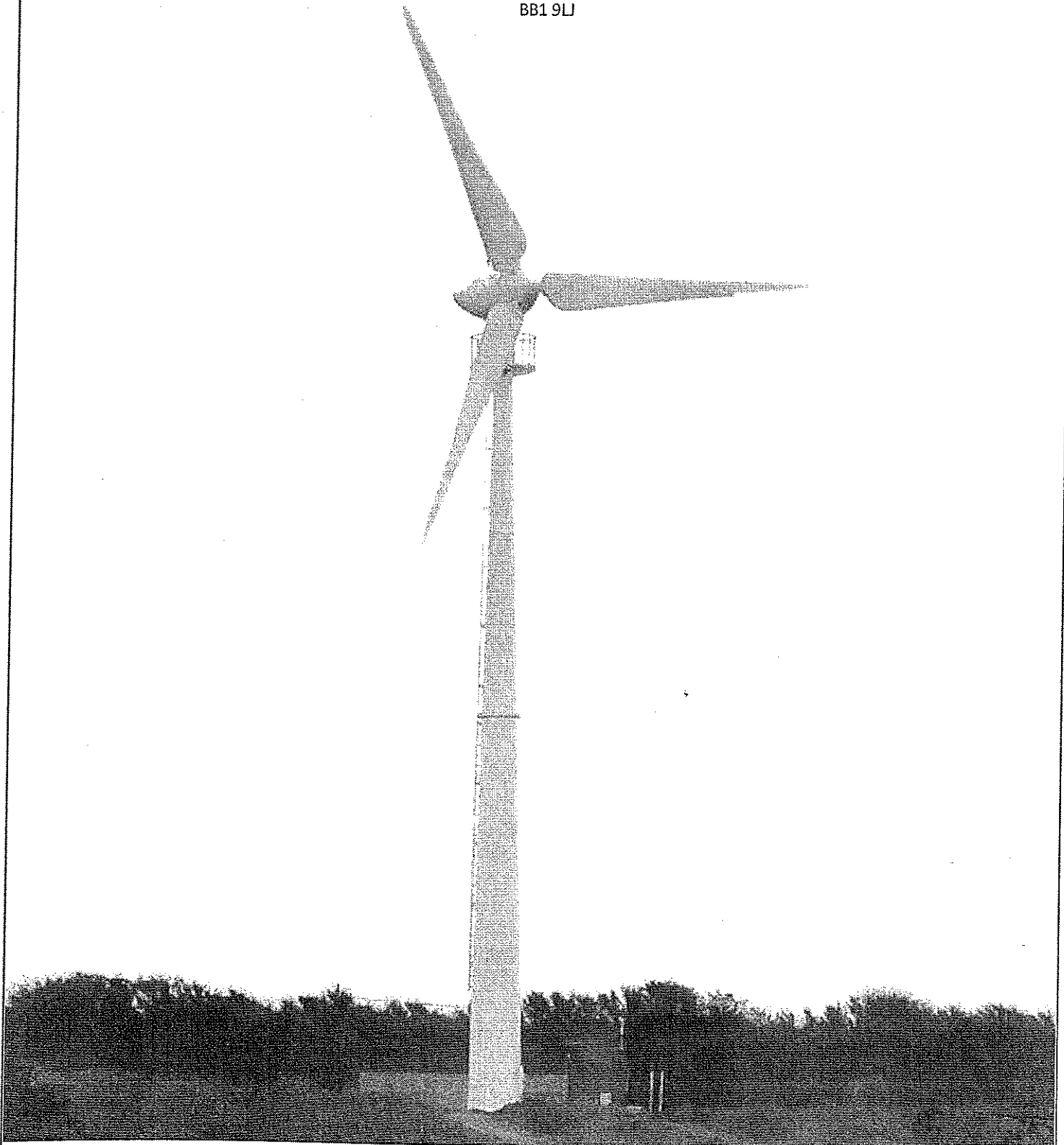


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SUPPLEMENTARY DOCUMENT FOR A SMALL SCALE RENEWABLE ENERGY DEVELOPMENT.

To aid the planning permission for the installation of 3no. Endurance E-3120 36.4m nacelle height, 9.6m blade radius (50kW) wind turbine located at:

Carr Hall Home & Garden Centre
Whalley Road
Wilpshire
Ribble Valley
BB1 9LJ





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1. INTRODUCTION

DC21 propose to install three Endurance E-3120 50kW wind turbines on land belonging to Carr Hall Home & Garden Centre. The turbines will be located on land to the south of the site.

The proposed turbines will be up to 36.4m in height to the nacelle with a 9.6m rotor radius – giving an overall maximum height of 46m. The site has good wind resource, of at least 6.4m/s, and the turbines will make use of this resource to provide sustainable low carbon power for the on-going operations of the site and will export a significant quantity of power to the National Grid. The scale of the turbines aligns well with the philosophy of distributed generation being encouraged by the UK Government – generation of power where it is required

It is anticipated that the turbines will generate approximately 600,00 kWh/yr, some of this generation will be used on-site with to off-set grid electricity use whilst the a significant proportion will be exported to the National Grid making a significant contribution to the UK Governments target that magnifies the proposal. In addition, the proposed turbines will contribute to the UK's stated targets for CO₂ emissions reduction. In light of this, the benefits of the turbines outweigh any impacts.

When assessing the balance of the impact verses the benefits, DC21 have considered other projects of a similar scale to aid in the interpretation of planning policy. DC21 believe the benefits of the project will be significant to the wider community through the export of renewable electricity to the local and national grid.

This view is supported by the Planning Inspectorate, as is evidenced in Appeal Ref: APP/Z4718/A/10/2138246 This appeal considered an application for two wind turbines that would produce 120,000 kWh/year of electricity, the original application was refused. The local planning authority was Kirklees (West Yorkshire), the appeal was successful in February 2011.

Extract from Planning Appeal Ref: APP/Z4718/A/10/2138246

25. The proposal would generate 120,000 kWh of electricity from a renewable source. Key principle (vi) of PPS22 notes that small-scale projects can provide a limited but valuable contribution to overall outputs of renewable energy and to meeting energy needs both locally and nationally. The production of this amount of electricity, from a renewable source, represents a significant benefit

26. The Council and others questions the proposal on the basis that the renewable energy it would produce is significantly greater than that required to serve Upper Prospect. However, that rather misses the point because the surplus produced would be fed back into the National Grid. Far from diminishing it, this magnifies the benefit of the proposal.

2. SITE CONTEXT

The proposed development will take place within the boundaries of Carr Hall Home & Garden Centre. The development will consist of three 50kW wind turbines mounted in concrete foundations. Each turbine will be accompanied by a small control cabinet. The wind turbines are designed to have an operational life of 30 years. They will be grid connected and are expected to generate 600,000kWh in each operational year.

The site is located on the Whalley Road (A666) between the settlements of Wilpshire and Langho. Reference to the Districtwide Local Plan shows that the proposed development site lies within an area of Green Belt.



The development will take place on an elevated area of land (190m AOD) selected because it offers very good wind speeds whilst maintaining significant separation distances from neighbouring dwellings. The nearest dwellings are some 400m from the proposed turbine positions.

3. PLANNING POLICY

There are a number of national and local planning policies relevant to the proposed development, these are discussed below.

3.1 PPS1 Climate Change

PPS1 encourages Local Planning Authorities to address the serious issue of climate change. Wind power is a secure, sustainable and low carbon energy source which contributes significantly to the reduction of atmospheric CO₂ and climate change mitigation.

The proposed wind energy development will generate around 600,000kWh of electricity each year. This amount of renewable electricity will deliver significant CO₂ savings. Using the DEFRA conversion factor¹ for wind generated electricity; the proposed development will save around 314 tonnes/CO₂ each year and around 9,420 tonnes/CO₂ over its 30 year lifetime.

3.2 Planning Policy Statement 22: Renewable Energy

PPS22 sets out the national planning policy for renewable energy generation. It covers a range of key wind energy issues and these are addressed below.

Proximity to dwellings

The scale of the proposed turbines and their appropriateness for different locations is discussed in PPS22 companion guide: Technical Annex: Wind, para 2 page 155. The proposed turbines are considered to be small in scale and therefore more suited for installation in populated areas than larger MW scale turbines found within wind farm developments.

The proposed development has been sited carefully away from dwellings with separation distances of 400m plus. The significant separation distance will ensure that visual impact is minimal and that impact from noise or shadow flicker will be neutral or negligible. These issues are addressed in more detail within this report.

Shadow Flicker

Under certain combinations of geographical position and time of day, the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the effect is known as 'shadow flicker'. It only occurs inside buildings where the flicker appears through a narrow window opening.

A single window in a single building is likely to be affected for a few minutes at certain times of the day during short periods of the year. The likelihood of this occurring and the duration of such an effect depend upon a

¹ 0.5246kg/CO₂e/kWh

number of factors: the direction of the building relative to the turbines; the distance from the turbines; the turbine hub-height and rotor diameter; the time of year; the frequency of bright sunshine and cloudless skies; and the prevailing wind direction.

Shadow flicker is a nuisance phenomenon rather than one likely to cause health issues for photosensitive individuals. PPS22 companion guide: Technical Annex: Wind, para 77, discusses potential issues with epilepsy. Around 0.5% of the population is epileptic and of these around 5% are photo-sensitive. Of photo-sensitive epileptics less than 5% are sensitive to the lowest frequencies of 2.5-3 Hz, the remainder are sensitive only to higher frequencies. The rotational speed of the proposed turbines is 42rpm which translates to a shadow flicker frequency of 2.1 Hz which is below the sensitive range.

Guidance from PPS22 companion guide: Technical Annex: Wind, para 73-78, suggests that flicker can occur at a distance of up to 10 rotor diameters and 130 degrees either side of North. In the case of the proposed development 10 rotor diameters is equivalent to 192m. The proposed wind turbines are around 400m from the nearest dwellings. Given this significant separation distance shadow flicker will not occur as a result of the proposed development.

Acoustic Impact Assessment

Based on ETSU/DTI publications, the technical annex to PPS22² suggests distancing turbines to impose a noise limit of 43dB on the nearest dwelling. According to PPS22;

"This is based on a sleep disturbance criteria of 35 dB(A) with an allowance of 10 dB(A) for attenuation through an open window (free field to internal) and 2 dB(A) subtracted to account for the use of LA90,10min rather than LAeq,10min. Both day- and night-time lower fixed limits can be increased to 45 dB(A) to increase the permissible margin above background where the occupier of the property has some financial interest in the wind farm".

The figures in this noise assessment are calculated using the methodology outlined by Rogers and Manwell³. This is a conservative methodology (detailed in equation 1) which assumes hemispherical noise propagation.

$$L_p = L_w - 10 \log_{10}(2\pi R^2) - \alpha R \quad \text{Equation 1 - Sound Pressure level (or "Noise")}$$

L_p is the sound pressure level (or "noise level") - measured in dB

L_w is the power level of the noise source (discussed further below) - measured in dB

R is the distance to the radiating noise source (in the case of a turbine it is measured to the nacelle)

α is the frequency dependant sound absorption coefficient. It is a constant and has been taken as 0.005 dB(A) per meter

Note that L_w (or the source power level) for the Endurance E-3120 has been characterised for wind speeds at an elevation of 10m by Hayes McKenzie (see appendix 07 for report).

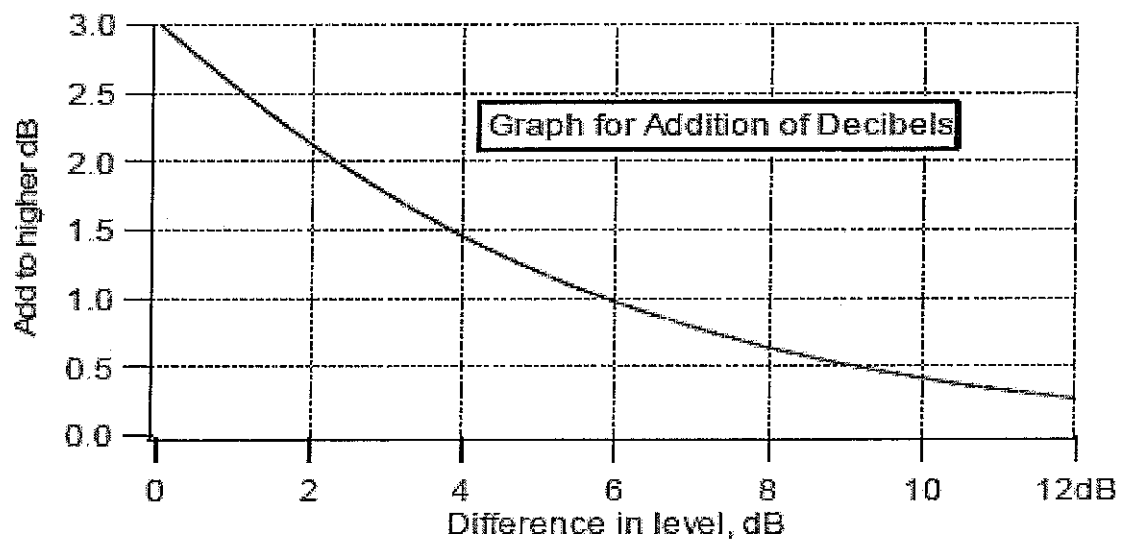
² <http://www.planning-applications.co.uk/pps22companionguide.pdf>

³ <http://www.windcows.com/files/WindTurbineNoiseIssues.pdf>

The estimated average wind speed at a 10m elevation (according to NOABL) for the Carr Hall site is 6.8m/s. The corresponding sound power level (L_{WP}) at the nacelle is 89 dB.

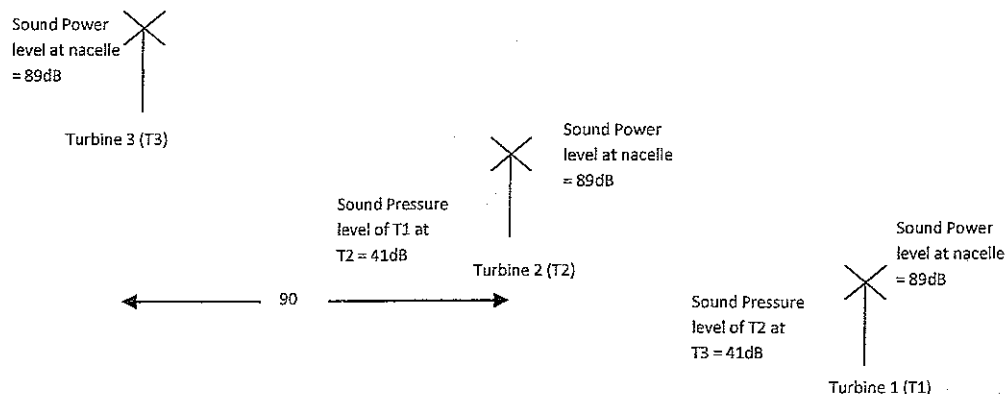
Carr hall is a 3 turbine site and so cumulative effect from each of the turbines has been taken into account. The methodology (Rogers and Manwell²) for combining noise levels is as follows:

Calculate the difference between sound power level of a turbine the and sound pressure level of the turbine which preceded it. This difference corresponds to a specific number of decibels, which should be added to the higher of the two sound power levels of the two turbines. This gives a figure representing the combined total sound power level (L_{WP}). The result is combined with a third source if appropriate (using the same methodology). The chart below can be used to calculate the number of decibels to add to the sound power level of each turbine.



Graph for Addition of sound levels (Rogers & Manwell²)

The turbines at Carr Hall will be spaced approximately 90m apart, at this distance the sound pressure level from one turbine at a neighbouring turbine is 41dB (see diagram below) – a difference in level of 48dB, this results in negligible addition. Following the same methodology the cumulative effect of two turbines upon the turbine nearest to a residential property is also negligible, however, a conservative penalty of 2dB has been assumed in the calculations here. Hence the power level (L_{WP}) used in calculating noise at various distances has been set to 91dB. Given this power level, the 43dB noise limit is reached at a distance of 90m from the nearest turbine.



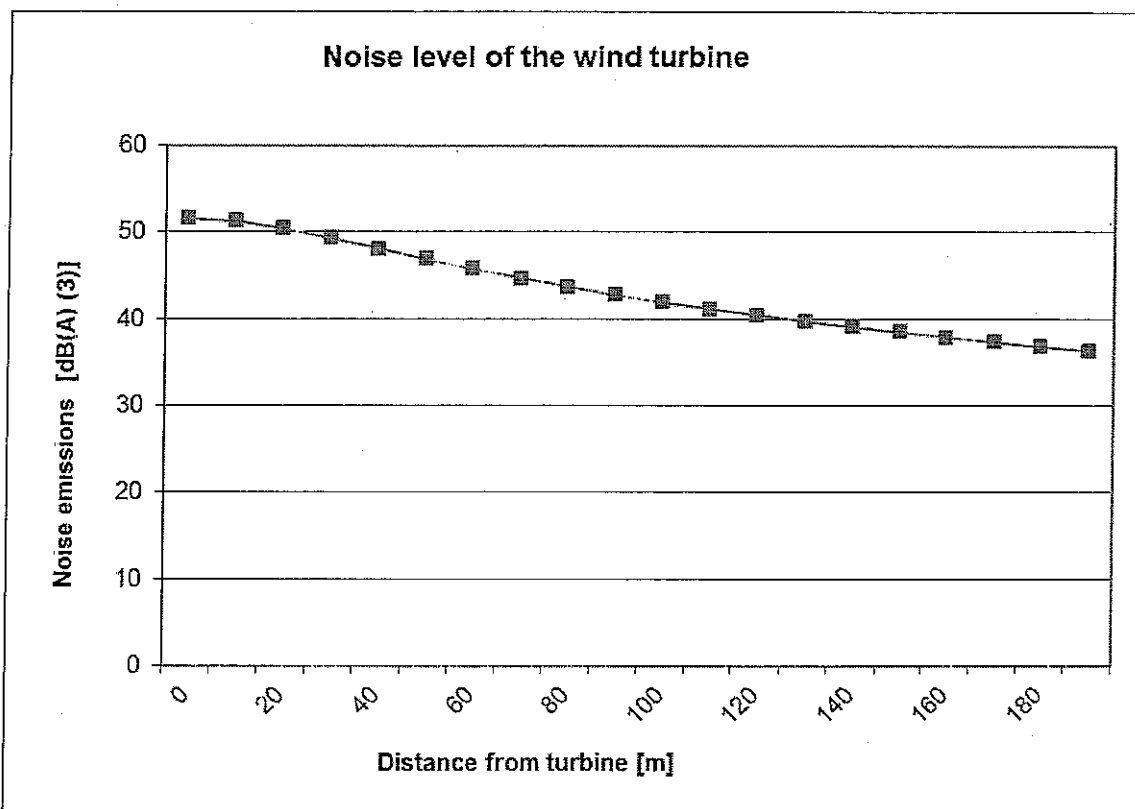
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← 90 →



The nearest dwelling is located 291m away from the closest turbine and belongs to the land owner. At this distance, the corresponding noise level is 32dB; significantly below allowable limits. The nearest non-residential building is located 247m away from the closest turbine. At this distance, the corresponding noise level is 34dB. Again this belongs to the land owner and is within allowable limits

The nearest residential dwelling not belonging to the land owner is 340m away from the closest turbine. At this distance, the noise level is well within allowable limits (at 31dB). The chart below shows the noise level over distance.

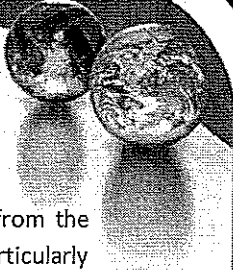


Conclusion

Following the conservative methodology set out above, the predicted noise levels at the nearest residential properties are well below the guidelines set out in PPS22 and no impact is expected.

Radar

The proposal site is located approximately 30km from Warton Aerodrome just inside the recommended consultation zone. The proposed turbines may be visible to Warton's PSR. The site lies outside of any other CAA or NATS consultation zones based on the information provided on the DECC website.



Proximity to Roadways and Public Rights of Way

The nearest major roadway is the A666 Whalley Road, which at its nearest point is over 400m from the proposed development location. The network of small roads to the south of the site is not particularly complex and the site is over 500m from the nearest minor road which is York Road to the south of the site

Reference to Ordnance Survey map data shows that a public footpath runs through Carr Hall Home & Garden Centre. However, at any given point this path is over 200m from the proposed turbines.

The proximity of wind turbines to public rights of way is discussed in PPS22 [Technical Annex: Wind, page 172, para 57] The fall over height is often described as an acceptable distance, and the minimum desirable distance is described such that the blades do not over sail the public right of way. As discussed, the distance between the turbines and the public right of way, at its nearest point, is over 300m. This exceeds both of these recommendations.

Access & Traffic

Access for site traffic will be via established access routes into and through the Carr Hall Garden Centre with temporary tracks created leading from the developed access routes to the proposal location. The works access route is marked out in the Site Plan (Drawing No. 12013_02). It is noted that the access road from the A666 to the garden centre buildings forms part of a public footpath. Access to this footpath would not be restricted at any point in the construction phase of the proposal.

Wind Turbine Colour and Reflected Light

The coatings of the turbine blades, hub, nacelle and tower have been carried out to industry standards in order to minimise reflected light. The proposed wind turbines are white in colour. There will be a small cabinet at the base of the turbine tower to house the turbine control system; this will be green in colour.

Ecology and Ornithology

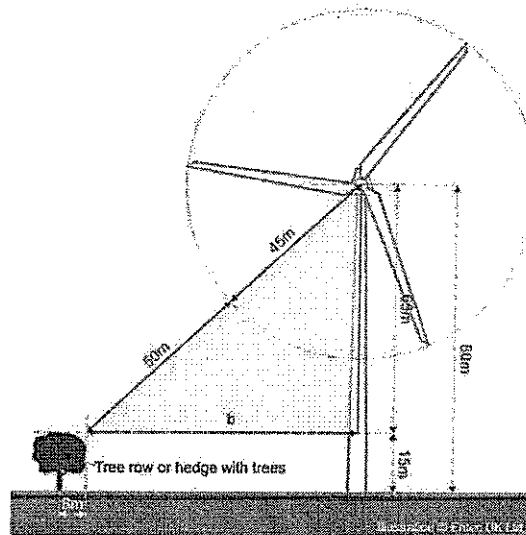
PPS22 Companion Guide: Technical Annex: Wind states that the impact of a wind farm on the local ecology should be minimal, and so for small turbines even less concern is due. In order to assess the potential impact of the proposed development on ecology and biodiversity reference was made to the District Wide Local Plan (DWLP) and an assessment of the site was undertaken using MAGIC.

The MAGIC search showed that the site is located within the Lancashire Plains and Valleys Natural Area. Natural Areas are not designations and both MAGIC and the DWLP revealed that there is only one designated environmental features within a 2000m radius of the proposed site. The single feature is Parsonage Reservoir which is a County Biological Heritage Site noted for Ferns and Flowering plants.

PPS22 states that risk of collision between moving turbine blades and birds is minimal both for migrating birds and for local habitats. It goes on to say that bird strike is most likely to occur if a wind turbine is erected directly in a migration path or where there are high concentrations of particular species. The MAGIC search revealed that there are no sensitive ecological or biological designations within a 2000m radius of the proposed wind turbines. This includes designations which could support bird habitats such as SAC's, SPA's, LNI's, LNR's and SSSI's. In addition, the site itself is marked by an absence of hedgerows and the turbines are

located at least 65m from the nearest stand of trees. In light of these facts, the threat of bird strike or disturbance to bird habitats is minimal.

In Technical Note TIN051, Natural England recommend that in order to minimise the risk to bat populations a stand-off distance of 50m should be maintained between features such as hedges or trees and the blade tip of a wind turbine. This is illustrated in the image below. The proposed development is in compliance with this recommendation and no adverse impact is anticipated in relation to local bats or bat roosts.



Extract: Natural England TIN051 Bats and Onshore Wind Turbines Interim Guidance.

Landscape and Visual Impact

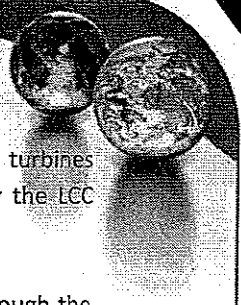
The proposal site lies in an area of open countryside halfway between the settlements of Wilpshire and Langho. Wilpshire is part of the Blackburn urban area and along with Langho is marked by extensive modern residential development. The proposal falls within the Lancashire Plains and Valleys Natural Area which in itself is not a designation. It does not fall within the AONB or any other landscape of local or national designation.

The landscape character of the area is defined by the Council⁴ as one of Lowland Fringe Farmland. This landscape type is described as having a tamed and intensely managed character and one which has been strongly influenced by human habitation.

The landscape around the proposal site is open with far reaching views; the landform is smooth, regular and flowing with consistent landcover all of which make the landscape less sensitive to wind energy development. This assessment is supported by the physical criteria established to consider sensitivity within Lancashire County Council's report, Landscape Sensitivity to Wind Energy Development in Lancashire (2005).

Our interpretation of the maps provided within the LCC study shows that the proposal site falls within Landscape Character Area 7A (Mellor Ridge). This area is defined within the report as having moderate sensitivity to wind energy development. The report states that this landscape is capable of accommodating small to medium scale wind energy developments. It defines small scale wind development as clusters of 2-5 wind turbines with a power rating upwards of 1.3MW. A typical 1.3MW wind turbine would be in the order of 100m high to blade tip with a blade length of around 31m. The proposal is for a cluster of 3 turbines with a

⁴ DWLP, Appendix 2, The Ribble Valley Landscape Character



power rating of 0.05MW. To blade tip these turbines will be 46m; the blade length is 9.6m. The turbines specified within this proposal then are significantly smaller than those considered appropriate by the LCC study.

A number of footpaths run around the proposal site including one footpath which runs directly through the garden centre from the A666 Whalley Road and bearing south east around the proposal location. Footpaths can be sensitive receptors since the attention of user is focussed on the landscape. In views from the closest footpaths the proposal would not be viewed as an incongruous feature in the landscape, rather it would be sited close enough to Carr Hall Garden Centre for the observer to understand that the devices are serving the needs of the site. Furthermore, proximity to the garden centre buildings should serve to dilute the visual impact of the proposal far more so than if it was being viewed in isolation.

According to OS map data and local plan maps an on-road cycle route runs around the site along Whalley Old Road to the southeast, York Road to the south and Parsonage Road to the southwest. At its nearest point this cycle route is over 450m from the proposal. The photomontage material submitted alongside this statement shows that in views from this approximate distance (cf. York Road and Snodworth Road) the proposal does not dominate the landscape.

The proposed turbines are of a modest scale and have been carefully designed to minimise physical intrusion in the landscape. Their tapered tower and compact nacelle assembly give them an elegant and non-industrial profile. The blades are also tapered presenting a less dominant rotor area and the downwind operation of this turbine does not require a tail fin which adds to the sleek and recessive appearance. Although visible within the surrounding landscape these turbines are unlikely to appear obtrusive or dominant and would not cause significant harm to the overall quality and character of the landscape.

Overhead Lines

The nearest overhead lines within the proximity of the proposed wind turbines are around 500m to the north along the A666 Whalley Road. General guidance from District Network Operators suggests a minimum clearance of fall over distance plus 9m. The proposed turbines have a fall over distance of 46m so are significantly beyond this recommendation.

Crime Prevention

Criminal damage or acts of vandalism against wind turbines are rare even in areas of high footfall around a turbine. Theft of metal from wind turbine installations is also very rare since there are generally few small parts which can be removed easily.

The Endurance E-3120 wind turbine has been designed to maximise safety for those with authorised access to the turbine and minimise the opportunity for unauthorised access. Maintenance access to the tower, nacelle and blades is obtained via a safe climbing ladder system which leads to a tower top platform. When not in use this ladder is securely locked at height. Access doors to the nacelle are also kept locked. The control cabinet at the base of the tower is kept locked at all times. The material from which the cabinet is constructed has been designed to with security in mind making it difficult to penetrate by unauthorised means.

The security features designed in to the control cabinet and Endurance-E3120 coupled with the absence of any small parts which could be easily removed and the remote location of the proposed development should mean that opportunities for criminal acts are negligible.



3.3 Ribble Valley Borough Council Districtwide Local Plan Adopted 1998

The following local planning policies have relevance:

- ENV3 – Open Countryside
- ENV4 – Green Belt
- ENV9 – Biological Heritage Sites
- ENV24 Renewable Energy
- ENV25 Assessment for Renewable Energy
- ENV26 Wind Energy

Policy ENV3: Open Countryside

Policy ENV3 seeks to protect the character of the landscape in areas outside of the AONB as well as conserve statutory designated areas and sites of biological interest and ancient woodland within areas of open countryside.

The proposal site lies within open countryside outside the AONB. It is part of the Lancashire Plains and Valleys Natural Area which in itself is not a designation but nonetheless is an attractive and valued landscape. In terms of statutory designated areas the proposal site is almost 700m away from the nearest locally designated Biological Heritage Site (Parsonage Reservoir). Reference to the local plan and to Defra's MAGIC tool suggests that there are no other environmentally sensitive or designated areas within a 2km radius of the site. In this regard the proposal is consistent with the requirements of Policy ENV3.

Both the landscape and visual assessment and photomontages material demonstrate that the proposal should have no significant impact on the character and overall quality of the surrounding landscape and is therefore consistent with Policy ENV3.

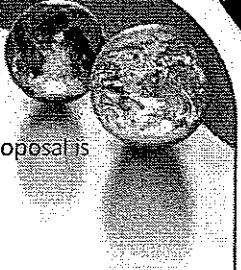
Policy ENV4: Green Belt

National policy on development in the green belt is set out in PPS22 para 13 which states:

'When located in the green belt, elements of many renewable energy projects will comprise inappropriate development, which may impact on the openness of the green belt. Careful consideration will therefore need to be given to the visual impact of projects, and developers will need to demonstrate very special circumstances that clearly outweigh any harm by reason of inappropriateness and any other harm if projects are to proceed. Such very special circumstances may include the wider environmental benefits associated with increased production of energy from renewable sources.'

The proposal has been carefully designed to minimise any impact on the openness of the green belt. The proposed 50kW turbines were selected for their modest size and are considered to strike the right balance between scale and benefit.

The wind speed at the proposal site is estimated at over 7 metres/second. This significant resource could see an annual energy generation of 600,000kWh enough to power 180 typical homes. In terms of CO₂ reduction this is a saving of 314 tonnes/CO₂ per annum or 9,420 tonnes/CO₂ over the 30 year lifetime of the turbine. This immense carbon saving will help to mitigate climate change and will contribute to local and national carbon reduction targets. The wider environmental benefits of the proposal therefore strongly outweigh any harm and the proposal is consistent with national planning policy in this regard. The sensitive scale and neat profile



of the proposed turbines should result in minimal impact on the openness of the green belt and the proposal is therefore consistent with policy ENV4 and PPG2.

Policy ENV9: Other Important Wildlife Sites

Policy ENV9 seeks to prevent development that might significantly harm features of interest which have led to the identification of County Biological Heritage Sites. The nearest County BHS to the proposed development is Parsonage Reservoir which lies some 700m to the southwest of the proposal site. Parsonage Reservoir has been identified for flowering plants and ferns. Given the nature of this special interest feature and the separation distance involved the proposal would cause no significant harm to this BHS.

Policy ENV24: Renewable Energy

The proposal would see the creation of a diverse, secure and sustainable energy supply capable of delivering significant carbon emissions reductions. As demonstrated within this document, the proposal is consistent with PPS22 as well as the relevant policies contained within the Ribble Valley Borough Council Districtwide Local Plan. In summary, these small scale turbines will not cause unacceptable harm to interests of acknowledged importance in the local environment and the proposal and is consistent with Policy ENV24

Policy ENV25: Renewable Energy

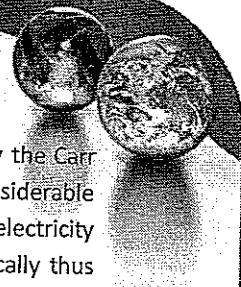
Policy ENV25 sets out three issues to which the council should give particular regard when assessing proposals for renewable energy schemes.

- i. The measures that would be taken, during and after construction, to minimise the impact of the development on local land use and residential amenity;*
- ii. The local and wider benefits the proposal may bring; and*
- iii. The fact that certain renewable energy resources can only be harnessed where the resource occurs*

Every care will be taken to minimise the impact on residential amenity during the construction phase of the proposed development. The installation process for small wind turbines such as these is relatively straightforward and fast requiring little in the way of excavation during the construction process and minimal site traffic. The proposal site is set a satisfactory distance from public footpaths and a significant distance from the nearest dwellings. Impact on residential amenity and recreational land use during construction will therefore be minimal.

Post-construction the proposal would have minimal impact on land use at the proposal site. Any impact on residential amenity post-construction in terms of noise, shadow flicker and visual intrusion will also be minimal. This has been demonstrated elsewhere in this document and in other supporting information.

In terms of the resource, the wind speed at the site is excellent and is estimated to be at over 7m/s. The proposal has the potential to produce up to 600,000kWh of secure, sustainable, low carbon electricity each year. In terms of wider benefits, this renewable electricity generation will equate to a potential carbon reduction of 315 tonnes per annum or 7,875 tonnes over the 25 year lifetime of the turbine through the displacement of fossil fuel generated electricity (calculated using DEFRA 2011 conversion factor of 0.5246kg/CO₂e/kWh). This immense carbon saving will help to mitigate climate change and it will contribute to local and national carbon reduction targets.



In terms of local benefit, the proposal will generate a large proportion of the electricity required by the Carr Hall Garden Centre site. This will allow the business to reduce its carbon footprint and make considerable financial savings on energy bills. Surplus electricity will be exported to the national grid and as electricity always travels to the nearest point of demand, it is highly likely that this surplus will be used locally thus providing direct local benefit, it will almost certainly not leave the local distribution network.

Policy ENV26: Wind Energy

Policy ENV26 states that the Borough Council will approve proposals for wind turbine generators providing:

- i. The visual impact of the proposal on the wider landscape is justifiable;*
- ii. The proposal does not harm any wildlife habitat or area of historical or architectural importance;*
- iii. The degree of nuisance caused by noise and shadow flicker to nearby residential amenities, agricultural operations, recreational areas or the function of the countryside is minimal;*
- iv. The proposal does not interfere with electromagnetic signals;*
- v. The design, colour layout and scale of turbines and ancillary structures including access roads must be appropriate to the character of the area;*
- vi. Connections to electrical grids and sub stations etc. must be acceptable in the landscape setting;*
- vii. Adequate restoration and after use provision must be made;*
- viii. Suitable parking facilities should be provided where appropriate.*

Items i-vi are addressed in detail within this document and within the supporting drawings. This material shows that the proposal is consistent with the requirements of Policy ENV26.

With regard to item vii, the land upon with the proposal will be sited could be easily restored should the turbines be decommissioned. The foundations could be grubbed up if necessary and the topsoil replaced.

With regard to item viii, additional parking facilities beyond those already provided within the Garden Centre site should not be required.

4. GRID CONNECTION

The wind turbines will be connected to the National Grid at an existing connection point within the Carr Hall Garden Centre site. The power from the turbines will be supplied to Carr Hall Home & Garden Centre through a cable running North East from the turbine locations. To minimise the visual impact of the required cabling, these will be buried underground.

5. ELECTROMAGNETIC INTERFERENCE (EMI)

The turbine components comply with the European Commission Directive on Electromagnetic Compatibility (89/336/EEC) and should not give rise to any unusual problems

6. RADIO TRANSMITTERS

There are no radio transmitters within the vicinity of the proposed development. No impact upon the operation of the telecommunication/radio masts in the vicinity of the proposed turbines is anticipated.

7. ICE THROW

PPS22 companion guide: Technical Annex: Wind, para 79, states: The build-up of ice on turbine blades is unlikely to present problems on the majority of sites in England. For ice to build up on wind turbines particular weather conditions are required, that in England occur for less than one day per year. (See Wind Energy Production in Cold Climates (WECO) (ETSU W/11/00452/00/REP).

8. CONCLUSION

This statement has shown that the proposed development aligns well with national and local planning policy. The turbines should integrate well into the landscape, impact on residential amenity and landscape character will be minimal and crucially the project will not present any significant risks to biodiversity or sensitive ecological features either on site or within the surrounding area. Carr Hall Home & Garden Centre will benefit from free, low carbon electricity with the balance of generated power being exported and used in the local district network. Furthermore, the CO₂ savings associated with the proposal will make a significant contribution to climate change mitigation. In conclusion, the benefits associated with this project outweigh any impact. It is hoped that the information provided herein gives sufficient detail on the proposed development. However, should anything further be required please do not hesitate to contact DC21.

9. APPENDIX

The following drawings are submitted as appendices to this statement

- 12013_01 Site Location Plan
- 12013_02 Site Plan
- 12013_03 Shadow Flicker
- 12013_04 Turbine Elevation
- 12013_05 Foundation Detail
- 12013_06 Photomontages
- 12013_07 Hayes and McKenzie Noise Assessment Report
- 12013 90818 Turbine Images
- 12013 Ecology Report

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PHOTOMONTAGES

To aid the planning permission for the installation of 3no. Endurance E-3120 36.4m nacelle height, 9.6m blade radius (50KW) wind turbine located at:

Cafr Hall Home and Garden Centre,

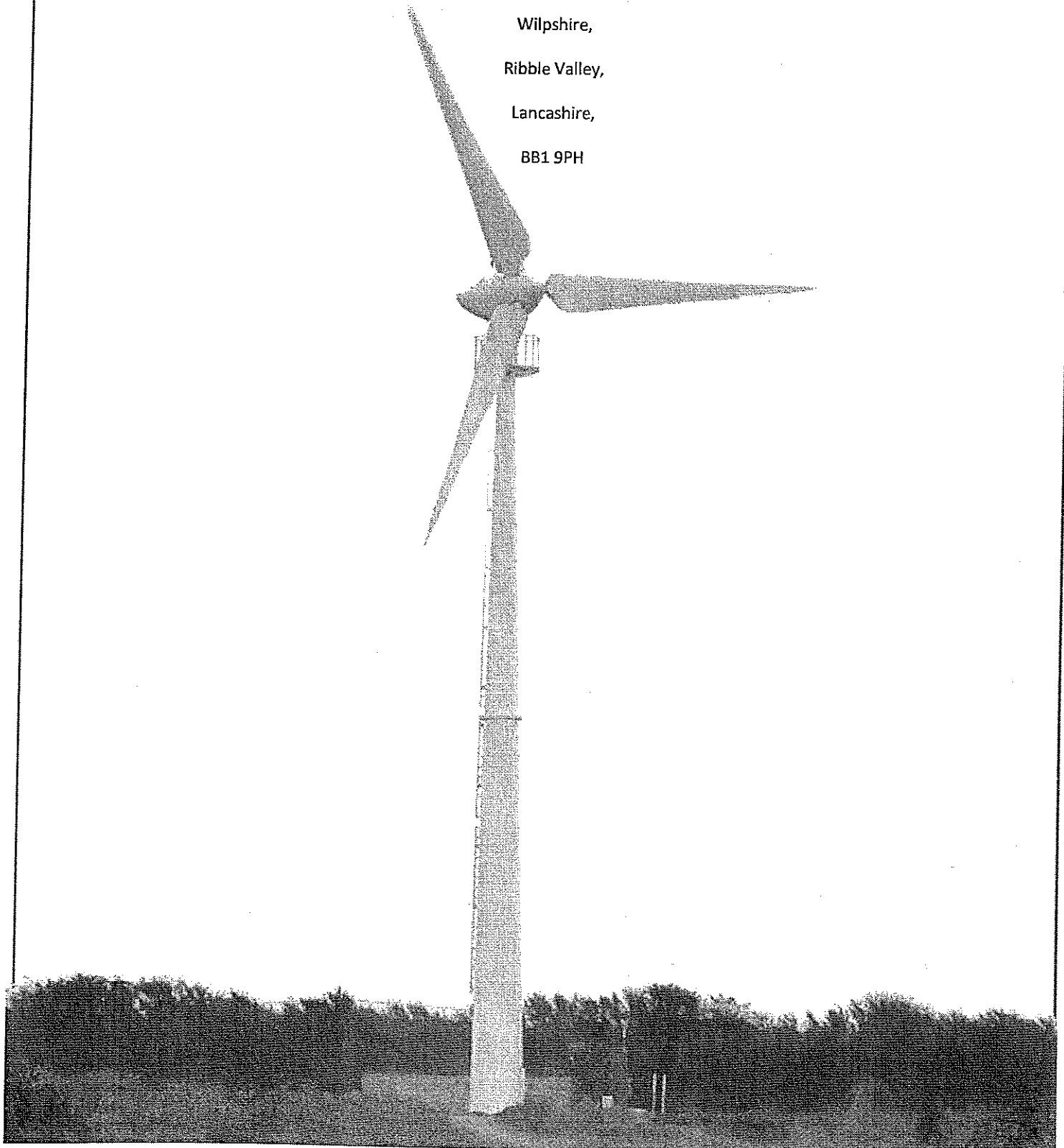
Whalley New Road,

Wilpshire,

Ribble Valley,

Lancashire,

BB1 9PH



Location Plan



Photo location ●

Wind Turbine ⊕

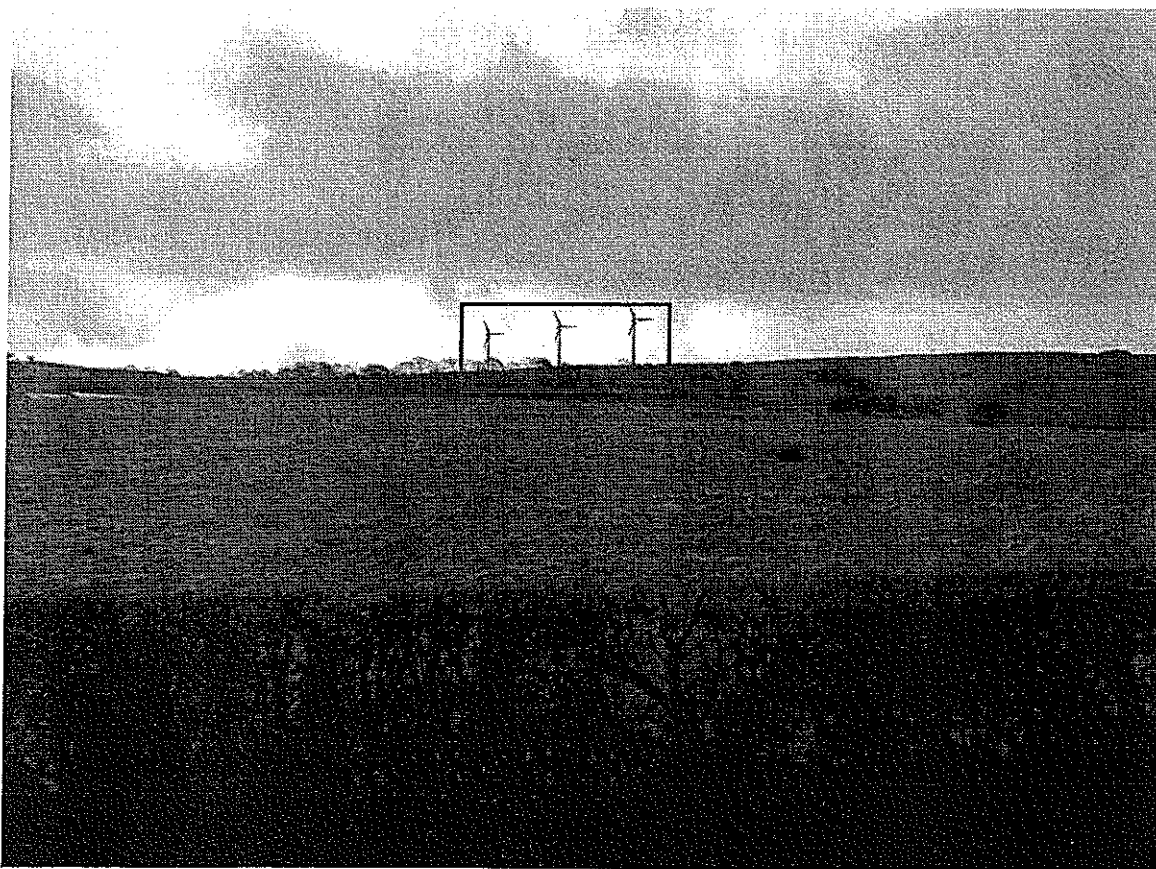
320120539P

Image 1 – Looking Southeast from Whalley Road

ashtonsmith
beyond design



Existing View



Proposed view – Wind turbines visible

Image 2 – Looking Southwest from Snodworth road



Existing View

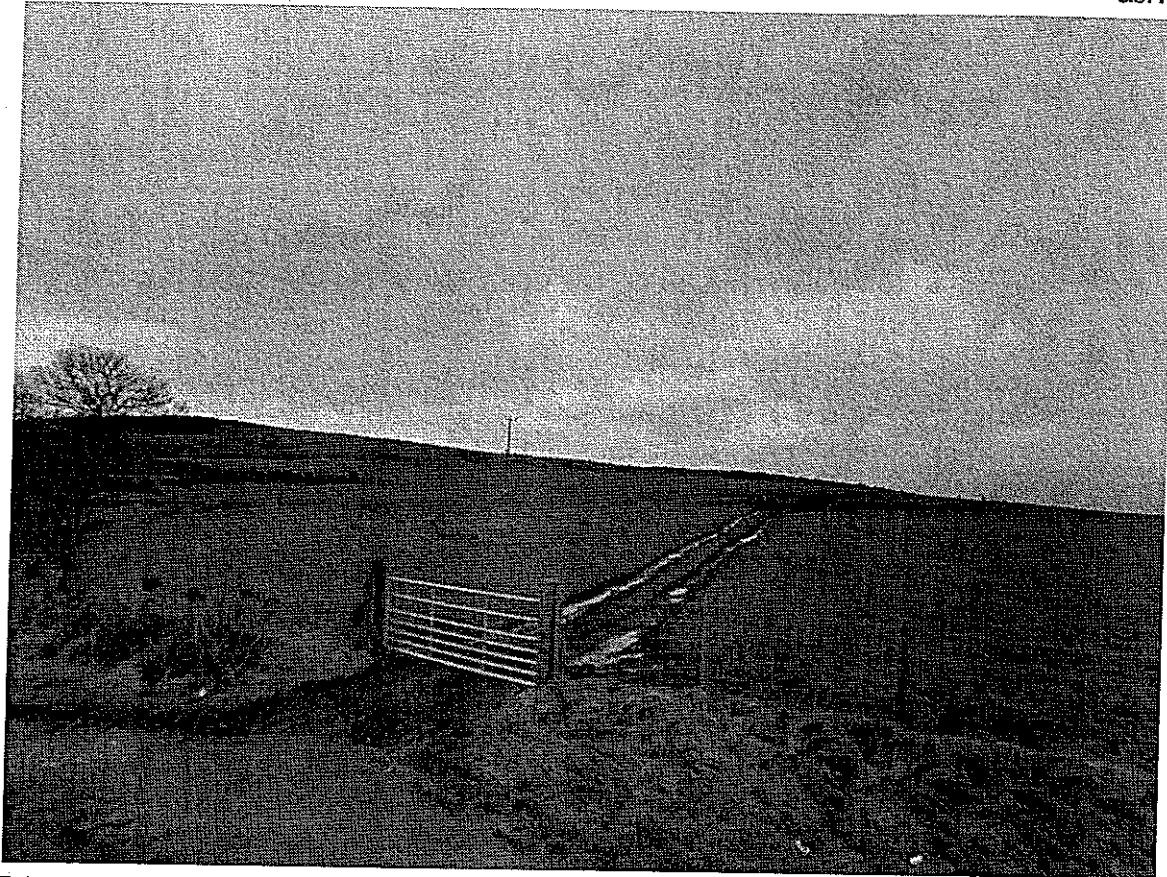


Proposed View – Wind turbines visible

320120539P

Image 3 – Looking Northwest from York Road

ashtonsmith
landscape design



Existing view



Proposed View – Wind turbines are visible in the distance



Photo 4 – Looking Southeast from Longsight Road



Existing view



Proposed View –Wind Turbines are just visible in the distance

Photo 5 – Looking Southwest from Snodworth Road

320120539P

ashtonsmith
beyond design



Existing View



Proposed View - Wind Turbines are visible in distance

Photo 6 – Looking Northeast from Hollowhead Lane



Existing view



Proposed view – tips of blades just visible behind trees in distance

HAYES MCKENZIE

PARTNERSHIP

320120539P



Prepared for:

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#107-19052 26th Ave
Surrey, BC
Canada, V3S 3V7*

Endurance E-3120 Wind Turbine Acoustic Performance Test

Report HM: 2300/R1

6th April 2011

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ENDURANCE E-3120 WIND TURBINE

ACOUSTIC PERFORMANCE TEST

Report HM : 2300/R1

6th April 2011

Final Version

Prepared by:	Rob Shepherd MEng, MIOA, AMImechE
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1. Introduction

- 1.1 A turbine noise performance test has been carried out on a Endurance E-3120 wind turbine at East Ash Farm located approximately 2.5km NNE of Bradworthy, Devon, in the UK.
- 1.2 The turbine has a hub height of 25m and a downwind rotor with a diameter of 19.2m. The wind turbine is passive stall regulated and has a rated power of 50 kW, which is achieved at a wind speed of approximately 9.5 m/s at hub height.
- 1.3 The objective of this test was to measure the noise performance characteristics of the wind turbine. The test consisted of measurement of the sound power level and tonal characteristics.
- 1.4 This noise test was conducted in accordance with IEC 61400-11 (2006) *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques*.
- 1.5 The noise measurements were carried out on 1st and 2nd February 2011.
- 1.6 Analysis of the data was carried out according to Method 2: *determination of wind speed with an anemometer* described in IEC 61400-11, as it was not possible to derive the wind speed from the power output of the turbine.



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2. Turbine Specification

- 2.1 The wind turbine is a three-bladed, passive stall regulated (constant speed) downwind turbine. The turbine's specification, as required by IEC 61400-11 and supplied by the manufacturer, is shown in Table 1 below

Table 1 - Turbine Specifications

Parameter	Value/Feature
Manufacturer	Endurance Wind Power
Model Number	E-3120
Serial Number	EWP-E-01-00123
Type (upwind/downwind)	Downwind, horizontal axis
Hub Height	25m
Rotor Diameter	19.2m
Tower Type	Free-standing Monopole
Turbine Control (stall/pitch)	Passive stall
Rotational Speed	Constant, 43 rpm
Rated Power	50 kW (at 9.5 m/s at rotor centre)
Cut-in Wind Speed	3.5 m/s
Cut-out Wind Speed	25 m/s
Control Software Version	PLC Phoenix Contact - PLC Code version 1.4.11
Rotor Control Devices	Full blade pitching (centrifugally activated)
Blade Type	Fibreglass / epoxy
Number of Blades	3
Gearbox Manufacturer	Flender
Gearbox Type	3 parallel stages
Generator Manufacturer	ABB
Generator Rotational Speed	1500 rpm



3. Measurement

Site Layout and Measurement Position

- 3.1 The site layout is shown at Appendix A. The site was characterised as open farmland bordered by hedgerows, which includes occasional trees. The E-3120 turbine which was the subject of these tests is the only wind turbine on this site.
- 3.2 IEC 61400-11 (2006) *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques* [1] specifies that the microphone used for the noise tests is to be mounted on a 1 m diameter ground-mounted board, facing in the direction of the wind turbine under test, at a distance corresponding to the tip height of the turbine (+/- 20%) directly downwind of the turbine. According to [1], measured noise data is valid as long as the board is within the downwind sector (i.e. +/- 15° of the directly downwind direction). Photos of the noise monitoring equipment set up are shown at Appendix B.
- 3.3 The microphone was fitted inside a primary hemispherical open cell foam wind shield of 90 mm in diameter laid flat on the board. The primary wind shield was surrounded by a secondary hemispherical foam wind shield of 450 mm diameter and 50 mm thickness. The insertion loss of the secondary wind shield is shown at Appendix C. The ground board was 20mm plywood with a diameter of 1000mm.
- 3.4 An anemometer was positioned approximately 45m upwind of the rotor of the turbine to measure wind speed. This is within the 2 to 4 D range specified by IEC 61400-11, where D is the rotor diameter of the wind turbine (here D = 19.2 m). Wind speed values are valid as long as the anemometer position is within the upwind sector (i.e. +/- 30° of the directly upwind direction), and the anemometer was moved during the survey to ensure that it was within allowable tolerances.
- 3.5 Wind speed and wind direction measurements, time-synchronised to the noise measurements, were made using a Second Wind C3 anemometer and an NRG #200P wind vane mounted at 10 m height connected to a Nomad 2 GSM data logger.
- 3.6 The microphone and the met mast position were within the acceptable ranges relative to the position of the nacelle, specified by IEC 61400-11 as discussed at paragraph 3.2, throughout the whole measurement period.



- 3.7 Table 2 details the measurement positions. R_{0i} is the reference distance on each measurement day and is the horizontal distance from the microphone to the nacelle. R_i is the resultant slant distance from the measurement position to the nacelle.

Table 2 - Distances and Reference Values

Parameter	Symbol	Value
Hub Height	H	25.3 m ¹
Rotor Diameter	D	19.2 m
Reference Distance day 1	$R_{0,1}$	31.5 m
Reference Distance day 2	$R_{0,2}$	31.5 m
Slant Distance day 1	R_1	40.4 m
Slant Distance day 2	R_2	40.4 m
Reference Roughness Length	z_{0ref}	0.05 m
Anemometer Height	z	10 m

- 3.8 During the noise tests the wind turbine was shut down for certain periods to allow for background noise measurements in order to establish the level of contribution from other noise sources.
- 3.9 Whilst on site, the average 1-minute electrical power output of the turbine was noted down from the turbine operational data once a minute during noise measurements; although at present there is not a power curve available to determine the 10m-height wind speed from the power output Method 2 described in IEC 61400-11 has therefore been used to determine the sound power level output of the turbine. It would be possible to re-analyse the data with wind speed derived from the electrical power output of the turbine once a power curve (measured according to IEC 61400-12) is available for this turbine
- 3.10 Amendment 1 (2006) to IEC 61400-11 states that where the hub height is lower than 30m, wind speed may be taken from an anemometer between 10m and hub height.

¹ Including concrete base



4. Instrumentation

4.1 Noise measurements were carried out using the following equipment:

General

Bruel & Kjaer Type 4231 calibrator (Serial No. 2218188)

Reference Position

01dB Symphonie Measurement System (Serial No. 00587)

PCB Microphone (Serial No. 377A02)

G.R.A.S. Type 26AK Pre-Amplifier (Serial No. 22826)

Secondary Windshield – Performance detailed at Appendix C

4.2 Meteorological measurements were carried out using the following equipment:

Logger

Second Wind Nomad II (S/N 05587)

Anemometer and Wind Vane

Second Wind C3 Anemometer (S/N 05531)

NRG #200P Wind Vane (S/N AV1102)

Temperature and Pressure Sensors

Second Wind Thermistor Temperature Probe (S/N TH84)

Setra Model 276 Barometric Pressure Sensor (S/N 4404452)

4.3 The noise measurement equipment was field calibrated prior to each measurement being performed and checked at the end. There was no recorded drift in the calibration of the equipment for any measurements. All equipment was within its laboratory calibration period.

4.4 Noise and wind measurements were time-synchronised to GMT, and all measurements were averaged over one minute, with the exception of the air pressure which was sampled every one minute.

Non-Acoustic Data

4.5 Table 3 below details the non-acoustic data reported as required by IEC 61400-11.

**Table 3 – Non-acoustic Data**

Wind speed determination method	Measured 10m height
Roughness length	0.05m
Air temperature, day 1	5.9 - 9.1°C
Air temperature, day 2	6.3 - 9.5 °C
Atmospheric pressure, day 1	1000.0 – 1002.0 mB
Atmospheric pressure, day 2	995.6 – 999.5 mB
Wind direction range, day 1	254.4 – 332.7°
Wind direction range, day 2	238.0 – 280.7°

5. Results

Measured Noise Levels

- 5.1 The measured 1-minute average L_{Aeq} noise data was plotted against the measured average 1-minute 10m height wind speed for operational periods and separately for shutdown periods. All noise data has been filtered such that any 1-minute period that was affected by specific extraneous noises such as vehicles passing on local roads, and any other anomalies, have been removed from the assessment.
- 5.2 Appendix D shows the measured operational noise and measured background noise at the microphone position, plotted against the measured 10m-height wind speed. Table 4 below details the number of operational data points in each wind speed range measured over the 2 days.
- 5.3 Appendix D also shows the measured 1-minute average L_{Aeq} noise data was plotted against electrical power output of the turbine.

Table 4 – Number of 1-minute Noise Data Points Recorded per Wind Speed Bin

Period		2	3	4	5	6	7	8	9	10	11	12	Total
1 st February 2011	Turbine Operational	2	33	31	16	14	1	0	0	0	0	0	97
	Background Noise	0	14	20	10	2	0	0	0	0	0	0	46
2 nd February 2011	Turbine Operational	0	0	0	1	12	20	19	9	16	12	5	94
	Background Noise	0	0	0	0	5	13	7	9	4	8	5	51
Totals	Turbine Operational	2	33	31	17	26	21	19	9	16	12	5	191
	Background Noise	0	14	20	10	7	13	7	9	4	8	5	97



Calculation of $L_{WA,k}$

- 5.4 IEC 61400-11 requires that a 4th order regression line is plotted through the measured operational data. A 3rd order polynomial regression line has been plotted through the turbine shutdown noise data, as it fits the data better than a 4th order regression line
- 5.5 The $L_{WA,k}$ has been calculated using the formula below specified in IEC 61400-11. A correction has been applied to account for secondary wind shield, which has been calculated from the measured 1/3 octave band levels across wind speeds from 3-12 m/s.

$$L_{WA,k} = L_{Aeq,c,k} - 6 + 10 \lg \left[\frac{4\pi R_1^2}{S_0} \right]$$

Where

$L_{Aeq,c,k}$ is the background corrected A-weighted sound pressure level at the integer wind speeds and under reference conditions

R_1 is the slant distance in meters from the rotor centre to the microphone as shown

S_0 is a reference area, $S_0 = 1\text{m}^2$

- 5.6 The results are plotted at Appendix E and in tabular form below at Table 5. Note that the results shown at Appendix E are not corrected for the presence of the secondary wind shield.

Table 5 - Calculation of Sound Power Level using 4th Order Regression Line

10m-height wind speed (m/s)	3	4	5	6	7	8	9	10	11	12
Total Measured Operational Noise Levels (dB L_{Aeq})	49.8	50.1	50.3	50.8	51.8	53.4	55.4	57.3	58.6	58.6
Background Noise Level (dB L_{Aeq})	35.9	35.8	36.6	38.2	40.3	42.9	45.8	48.6	51.4	53.8
Difference Between Total and Background Noise (dB)	13.9	14.3	13.7	12.6	11.5	10.5	9.6	8.7	7.3	4.8
Background Corrected Sound Pressure Level, $L_{Aeq,c,k}$ (dB L_{Aeq})	49.6	49.9	50.1	50.5	51.5	53.0	54.9	56.7	57.7	57.3
Secondary Wind Shield Correction	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
Apparent Sound Power Level, $L_{WA,k}$ (dB L_{WA})	87.1	87.3	87.6	88.1	89.0	90.6	92.4	94.3	95.4	94.9*

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- 5.7 It should be noted that the difference between the total measured noise and measured turbine shutdown noise levels at 12m/s is less than 6dB. Therefore 1.3dB has been subtracted from the measured turbine noise as required by IEC 61400-11 and the result marked with an '*'

1/3 Octave Band Data

- 5.8 As required by IEC 61400-11, the three one minute average periods closest to each integer wind speed have been used to calculate the energy average 1/3 octave band spectra between 20 and 10kHz for the operational turbine noise. The average background noise spectra have also been calculated from the nearest three nearest 1-minute average background noise periods closest to each integer wind speed. The results are plotted at Appendix F, which also shows the octave band levels. The data has been corrected for the insertion loss of the secondary wind shield.
- 5.9 It should be noted that there were only two 1-minute periods available for the operational wind speed of 12m/s. It should also be noted that only two 1-minute periods were available for the shutdown periods wind speed of 6, 8, and 10 m/s, and no data available for a wind speed of 7m/s
- 5.10 The sound power level has been calculated for wind speeds for 6-8m/s as required by IEC 61400-11 for each 1/3 octave as measured and the results are shown in Appendix G, which also shows the octave band levels. The operational turbine noise spectra have been corrected for the presence of background noise by subtracting the average background noise. Note that the 6m/s background noise has been subtracted from the 7m/s spectrum as there was no background noise data for 7m/s. Where the difference between the measured turbine noise and measured background noise levels is less than 6dB the measured turbine noise has been corrected for background noise by subtracting 1.3dB as required by IEC 61400-11 and the result marked with an '*'
- 5.11 It should be noted that it has not been possible to calculate the 1/3 octave sound power levels for wind speeds above 8m/s due to the influence of background noise

Narrow Band Analysis

- 5.12 The presence of tones has been determined for wind speeds of 6-10 m/s following the procedure set out in IEC 61400-11, with the results presented at Appendix H. Note that the data has not been A-weighted or corrected for the insertion loss of the secondary wind shield.



- 5.13 The results of the narrow band analysis identified the presence of tones at 6m/s wind speed. No tones were identified at any other wind speed

6. Other Acoustic Characteristics

- 6.1 The operational noise from the turbine can be characterised by aerodynamic noise from the blades rotating, together with a mechanical component from the gearbox.
- 6.2 It should be noted that the wind turbine tower is fitted with an external ladder and safety line. At wind speeds above about 8m/s a tonal noise was noted during the background noise measurements due to wind passing the ladder and safety line. This can be seen on the narrowband analysis charts shown Appendix H for wind speeds of 8-10 m/s at frequencies of 840 and 1015 Hz.
- 6.3 An audible pulse was noted from the wind turbine at higher wind speeds as the turbine blades pass the wake caused by wind around the tower. No assessment of impulsivity has been carried out, as it was not deemed significant enough to warrant further analysis

7. Uncertainty

- 7.1 An assessment of measurement uncertainty has been carried out, based on the procedure outlined in Annex D of IEC 61400-11, as follows: Type A uncertainties are evaluated from the extent to which the measured values vary around the derived mean based on the regression analysis; Type B uncertainties are a measure of the assumed accuracy of various factors in the measurements procedure and have been based on the factors shown at the Annex D. The total uncertainty U_C is evaluated from the square root of the sum of the squares of each individual component.
- 7.2 The standard uncertainty of the apparent sound power is calculated in Table 6 using Equation D 1 in Annex D of IEC 61400-11. The total uncertainty of the measured L_{WA} calculated from all uncertainties, as given in Table 7, is ± 1.6 dB for the Reference Position.

Table 6 - Calculation of L_{WA} Uncertainty U_A

Number of Elements	191
Standard Error U_A	0.728

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Table 7 - Calculation of Uncertainty U_C

Type A Uncertainty	
Standard Error of L_{WA} Estimate from Regression Analysis	0.728
Type B Uncertainty	
Calibration	0.2
Instrument	0.2
Board & Mounting	0.3
Distance	0.2
Impedance	0.1
Turbulence	0.4
Wind Speed Measured	1.2
Background	0.3
Total Uncertainty	
Total, U_C	1.6

8. Conclusions

- 8.1 A noise test has been carried out, according to IEC 61400-11 on an Endurance E-3120 Wind Turbine at East Ash Farm, Bradworthy, Devon, to measure the sound power level and tonal characteristics.
- 8.2 The apparent sound power level of the wind turbine was calculated over a range of wind speeds from 3-12m/s together with the one third octave band levels for wind speeds of 6-8 m/s. It was not possible to calculate the 1/3 octave sound power levels above 8m/s due to the contrition of background noise.
- 8.3 The tonal output from the Endurance E-3120 turbine has been assessed using the methodology prescribed by IEC 61400-11 for wind speeds of 6-10 m/s and has been determined to be not tonal, except at a wind speed of 6m/s where tones were identified.



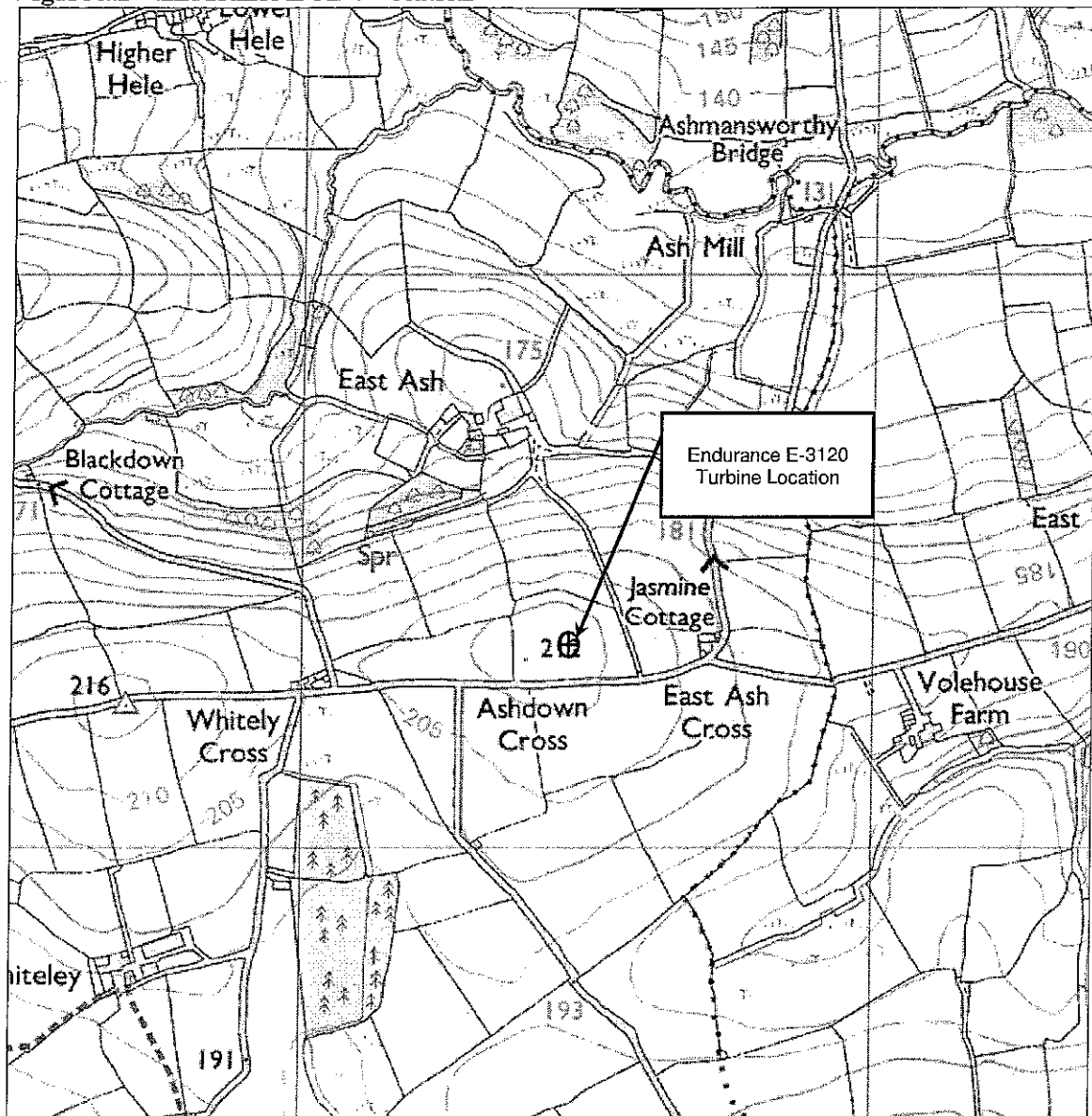
9. References

- [1] BS EN 61400-11 *Wind turbine generator systems – Part 11. Acoustic noise measurement techniques*, (Amendment 1 May 2006), International Electrotechnical Commission

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Appendix A Site Layout

Figure A1 – Endurance E-3120 Location



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Appendix B Site Photos

Figure B1 –Photo Showing Turbine and 10m Meteorological Mast

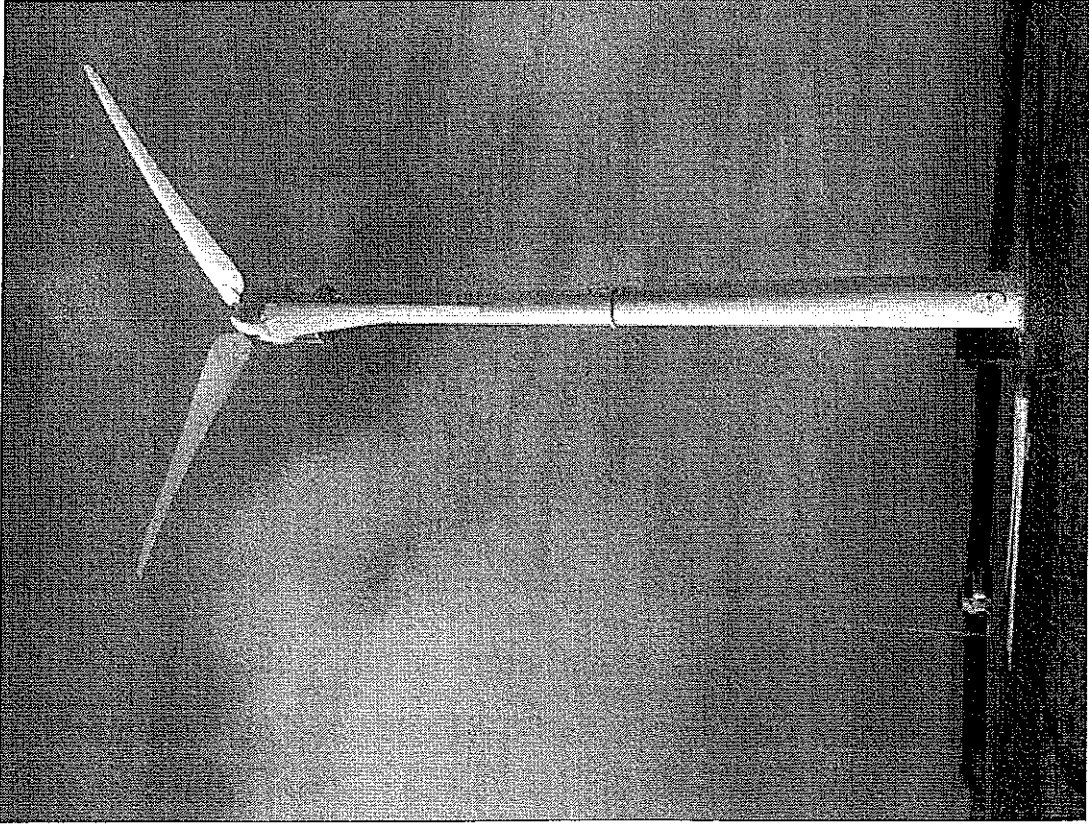


Figure B2 –Photo Showing View of Ground Board from Turbine



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Figure B4 -Photo Showing Detail of Ground Board Location

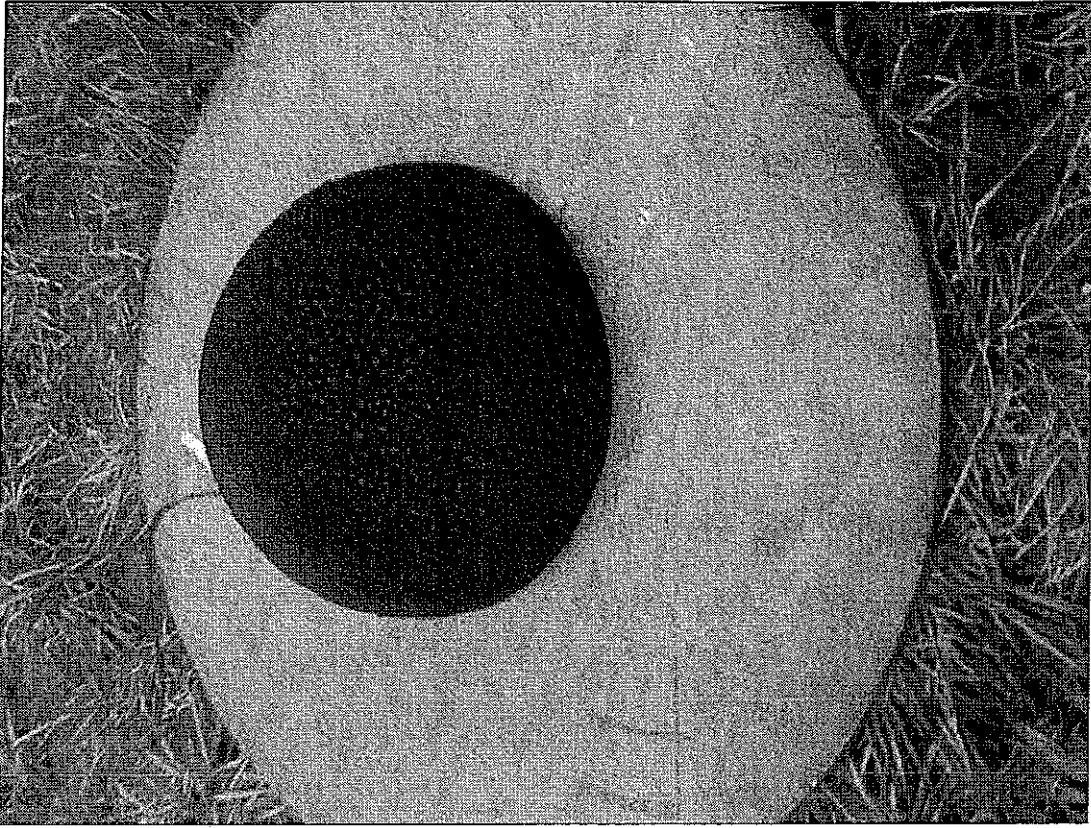
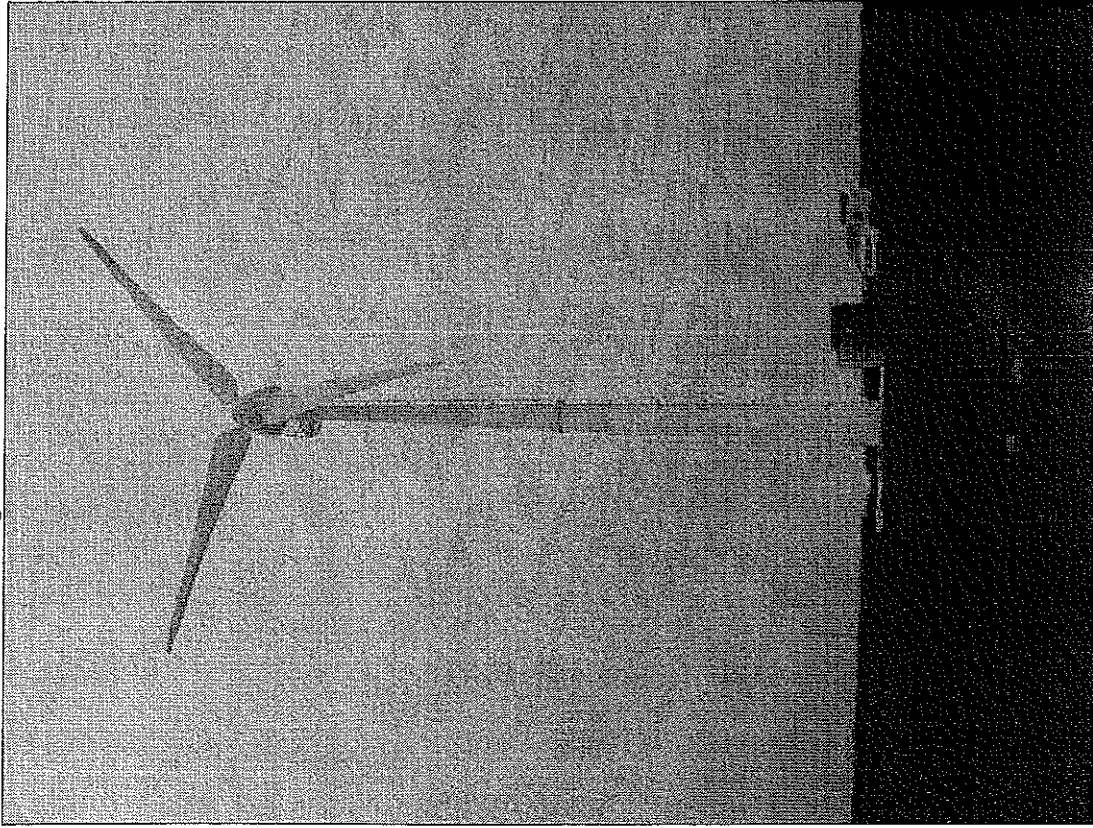


Figure B3 -Photo Showing Noise Measurement Location



Appendix C

Secondary Wind Shield Insertion Loss



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TEST REPORT No : MI/04/04

DATE OF ISSUE : 21 September 2004

Page 1 of 6

Measurement of the Insertion Loss of Microphone Windshields

CLIENT:

Haynes M^cKenzie Partnership
Lintrathen House
West Dean
Salisbury
SP5 1JL

JOB NUMBER:

A04/65

TEST SAMPLE:

Double skin tripod mounted and secondary windshields

MANUFACTURER:

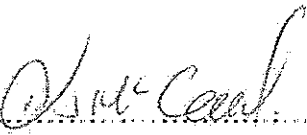
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DATE RECEIVED:

1 September 2004

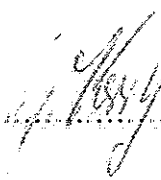
DATE OF TEST:

17 September 2004

Signed: 

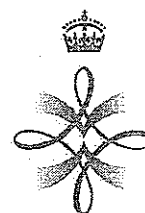
D J M'Caul

Laboratory Manager

Approved: 

G Kerry

Technical Manager



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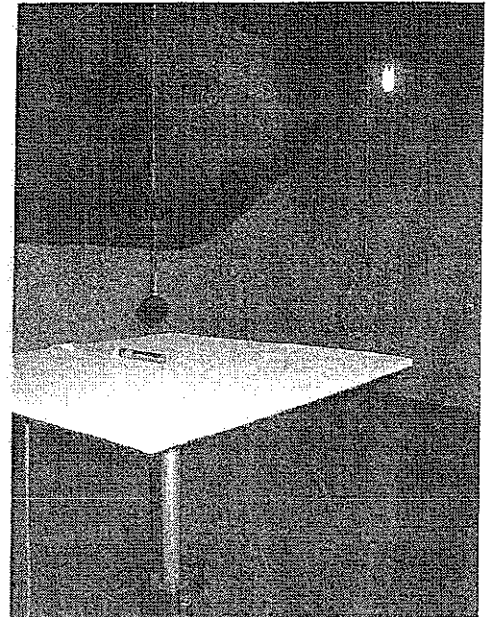
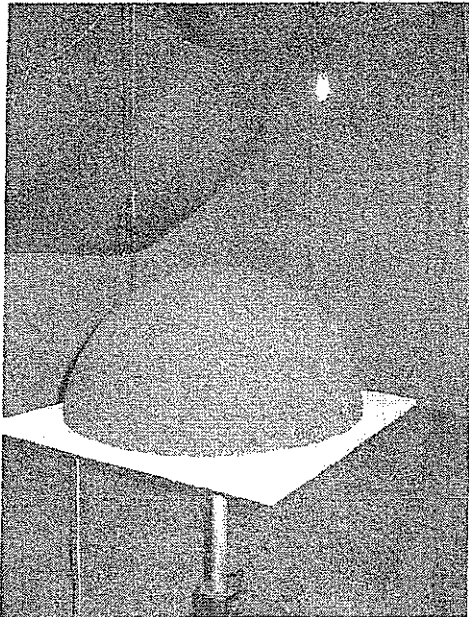
2000

TEST SAMPLES

Description of Test Samples

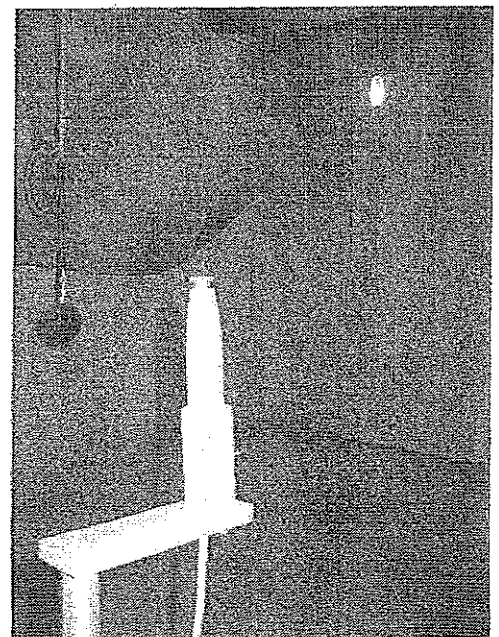
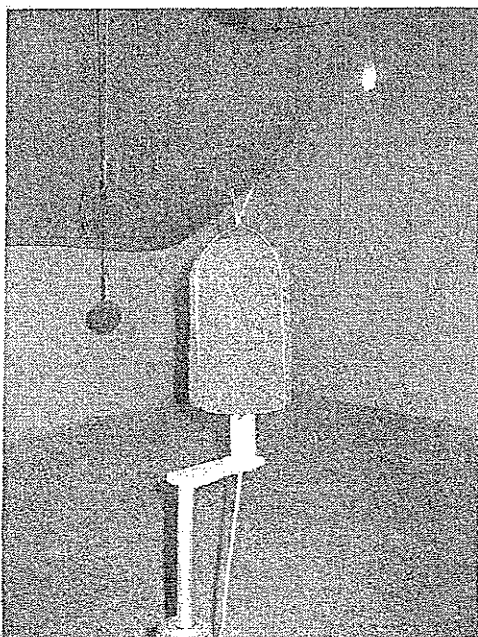
Test Ref: MI/04/09/03

Secondary windshield, external diameter 450mm, mounted on a section of plasterboard with dimensions: 480mm x 480mm x 12.5mm and weighing 2.5kg



Test Ref: MI/04/09/04

Double skin tripod mounted windshield, external diameter 120mm.



DESCRIPTION OF TEST PROCEDURE

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Description of Test Facility

The tests were carried out in the large reverberation room at the University of Salford. The room has been designed with hard surfaces and non-parallel walls to give long empty room reverberation times with uniform decays. It has the shape of a truncated wedge. In addition 11 plywood panels, each panel 1.22m x 2.44m, were hung in the room to improve the diffusivity of the sound field. The test sample was placed in the centre of the room and >1100mm above the floor of the room. The excitation signal comprised wide band random noise played into the room via a loudspeaker system mounted in a cabinet facing a corner. The room is 7.4m long x ~6.6m wide x 4.5m high. It has a volume of 225m³ and a total surface area of 243m².

Test Procedure

Measurements were made over a frequency range of 20Hz to 20,000Hz in one-third octave bands with and without the test object in place. Measurements were carried out consecutively to avoid significant changes in relative humidity and temperature that influence air absorption at higher frequencies. The measurement period was 60 seconds. The insertion loss of the test object was determined by subtracting the level with the test object in place from the level without the test object in place:

$$\text{insertion loss} = \text{unoccluded} - \text{occluded} \quad (\text{dB})$$

A total of 12 measurements for each situation were taken, six each for two loudspeaker positions. These were then averaged.

3 EQUIPMENT

Item	Departmental Record No.
Norwegian Electronics 1/3 octave band real time analyser type 840 with in-built random noise generator	RTA2
Quad 510 power amplifier	PA7
Bruel & Kjaer microphone power supply type 2804	1848095
2 off broadband loudspeakers	LS3 & LS4
1 off G.R.A.S. random incidence condenser microphones type 40AP in the receiving room	M16
1 off Norsonic Multiplexer type 834A	MP2
HP Brio Pentium personal computer and related peripheral equipment (printer, plotter, monitor etc.)	COM6
Yamaha GQ1031BII graphic equalizer	GEQ1

RESULTS

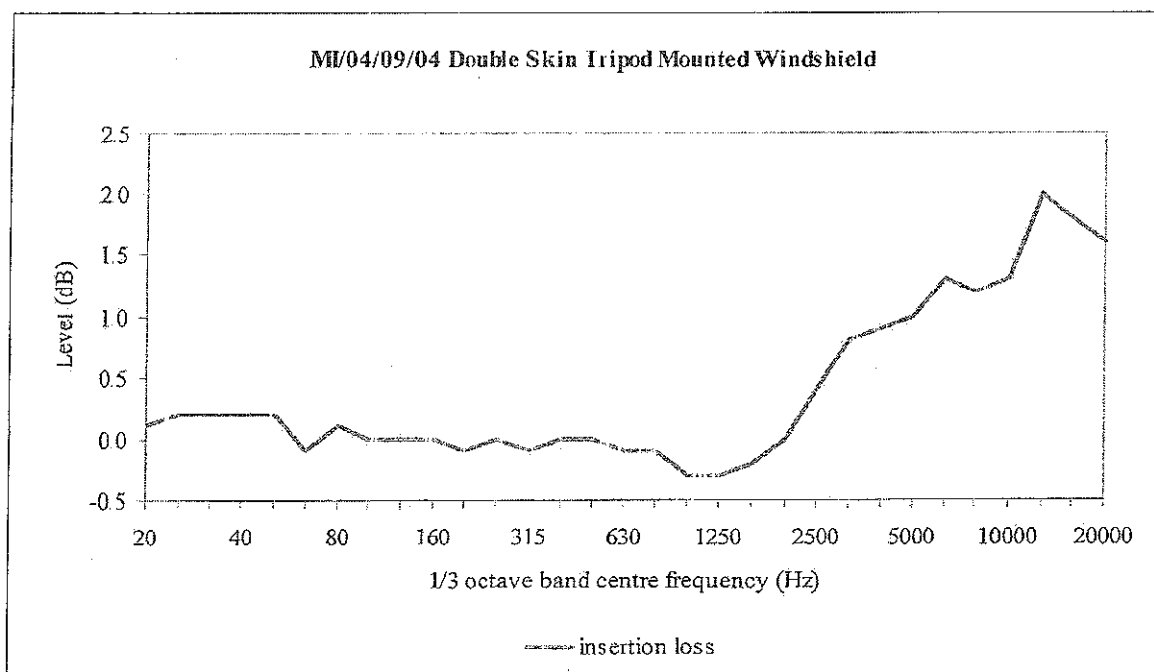
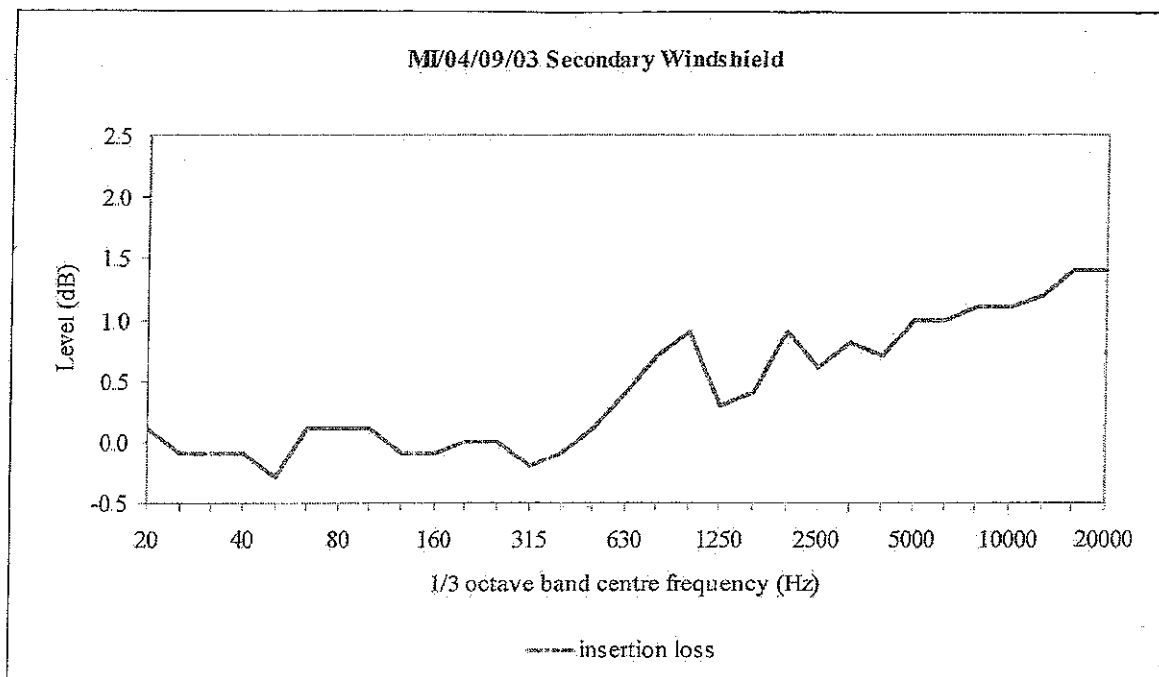
The insertion loss values at one third octave band intervals are given in the tables overleaf.

	MI/04/09/03	MI/04/09/04
Temperature in reverberation room °C:	22.5	22.6
Relative humidity in reverberation room %:	46.6	46.2

The results here presented relate only to the items tested and described in this report.

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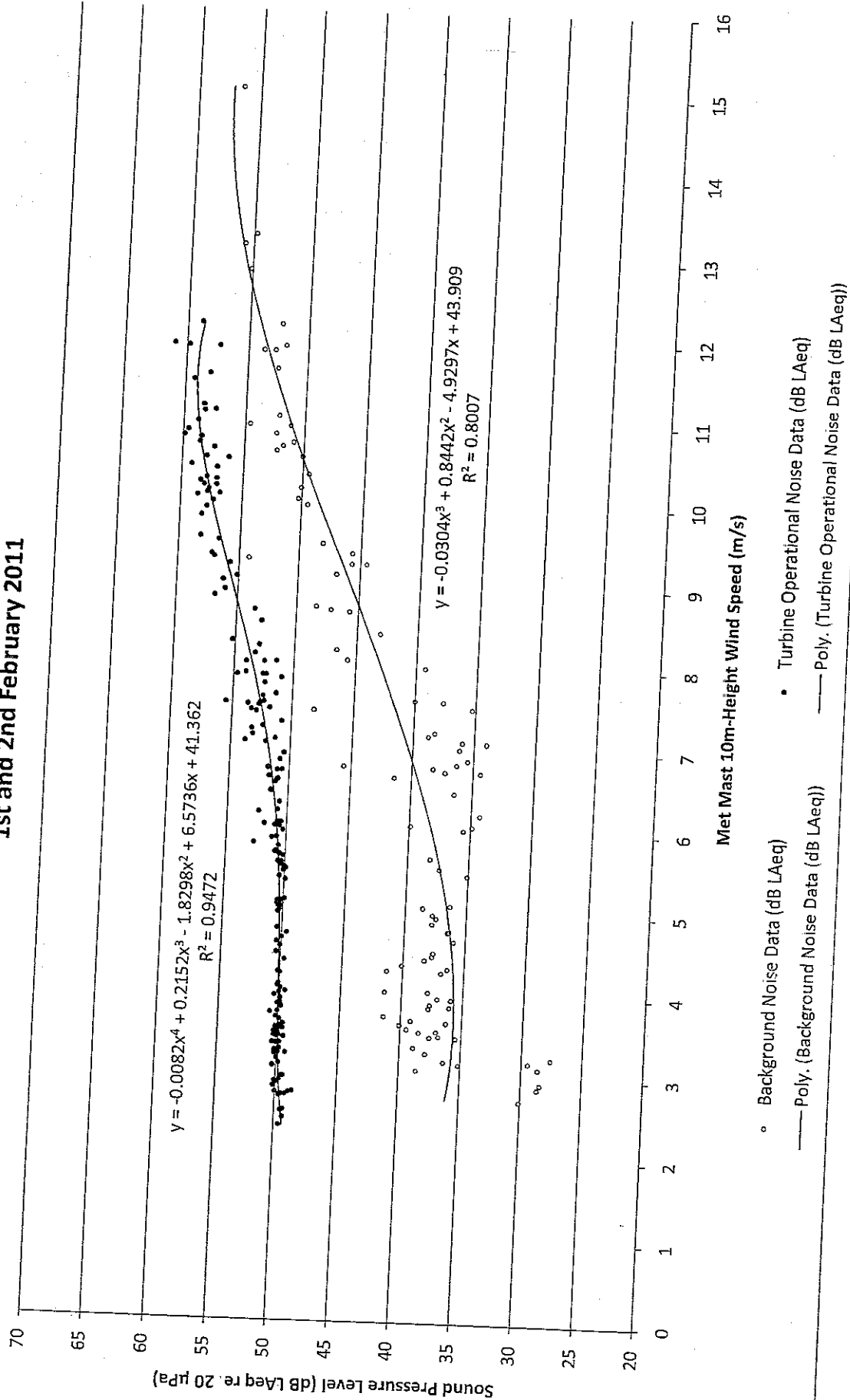
1/3	MI/04/09/03			MI/04/09/04		
OBCF	unocc	occ	insertion loss	unocc	occ	insertion loss
(Hz)	(dB)	(dB)	(dB)	(dB)	(dB)	(dB)
20	53.6	53.5	0.1	53.1	53.0	0.1
25	60.2	60.3	-0.1	59.5	59.3	0.2
31.5	74.4	74.5	-0.1	75.1	74.9	0.2
40	79.6	79.7	-0.1	80.1	79.9	0.2
50	79.5	79.8	-0.3	79.7	79.5	0.2
63	80.8	80.7	0.1	81.2	81.3	-0.1
80	78.4	78.3	0.1	78.7	78.6	0.1
100	85.8	85.7	0.1	85.3	85.3	0.0
125	88.9	89.0	-0.1	87.7	87.7	0.0
160	86.0	86.1	-0.1	85.3	85.3	0.0
200	85.8	85.8	0.0	85.6	85.7	-0.1
250	87.7	87.7	0.0	86.3	86.3	0.0
315	88.7	88.9	-0.2	86.1	86.2	-0.1
400	89.1	89.2	-0.1	85.6	85.6	0.0
500	90.2	90.1	0.1	86.9	86.9	0.0
630	89.4	89.0	0.4	86.5	86.6	-0.1
800	88.1	87.4	0.7	85.4	85.5	-0.1
1000	88.6	87.7	0.9	85.9	86.2	-0.3
1250	88.8	88.5	0.3	86.1	86.4	-0.3
1600	88.7	88.3	0.4	86.1	86.3	-0.2
2000	89.5	88.6	0.9	86.7	86.7	0.0
2500	89.2	88.6	0.6	86.7	86.3	0.4
3150	87.9	87.1	0.8	85.9	85.1	0.8
4000	88.9	88.2	0.7	86.2	85.3	0.9
5000	89.1	88.1	1.0	86.5	85.5	1.0
6300	73.1	72.1	1.0	70.8	69.5	1.3
8000	63.1	62.0	1.1	60.9	59.7	1.2
10000	61.2	60.1	1.1	59.4	58.1	1.3
12500	59.7	58.5	1.2	58.4	56.4	2.0
16000	53.8	52.4	1.4	51.4	49.6	1.8
20000	44.4	43.0	1.4	40.3	38.7	1.6



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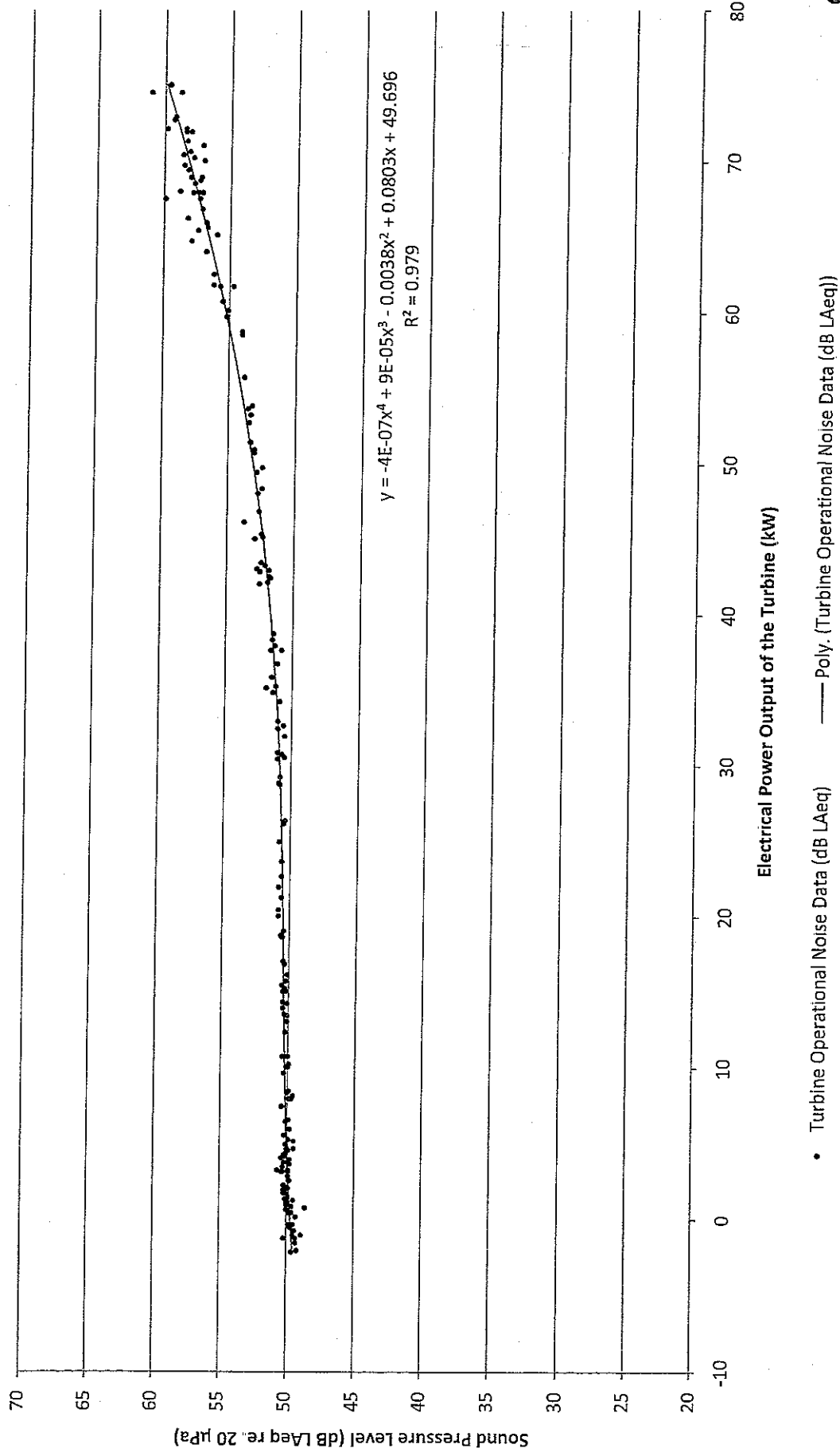
Appendix D
Measured Turbine and Background Data

Endurance E-3120 - Noise Measurements Measured Turbine and Background Noise Levels 1st and 2nd February 2011



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Endurance E-3120 - Noise Measurements Measured Turbine Noise Levels Plotted against Electrical Power Output 1st and 2nd February 2011

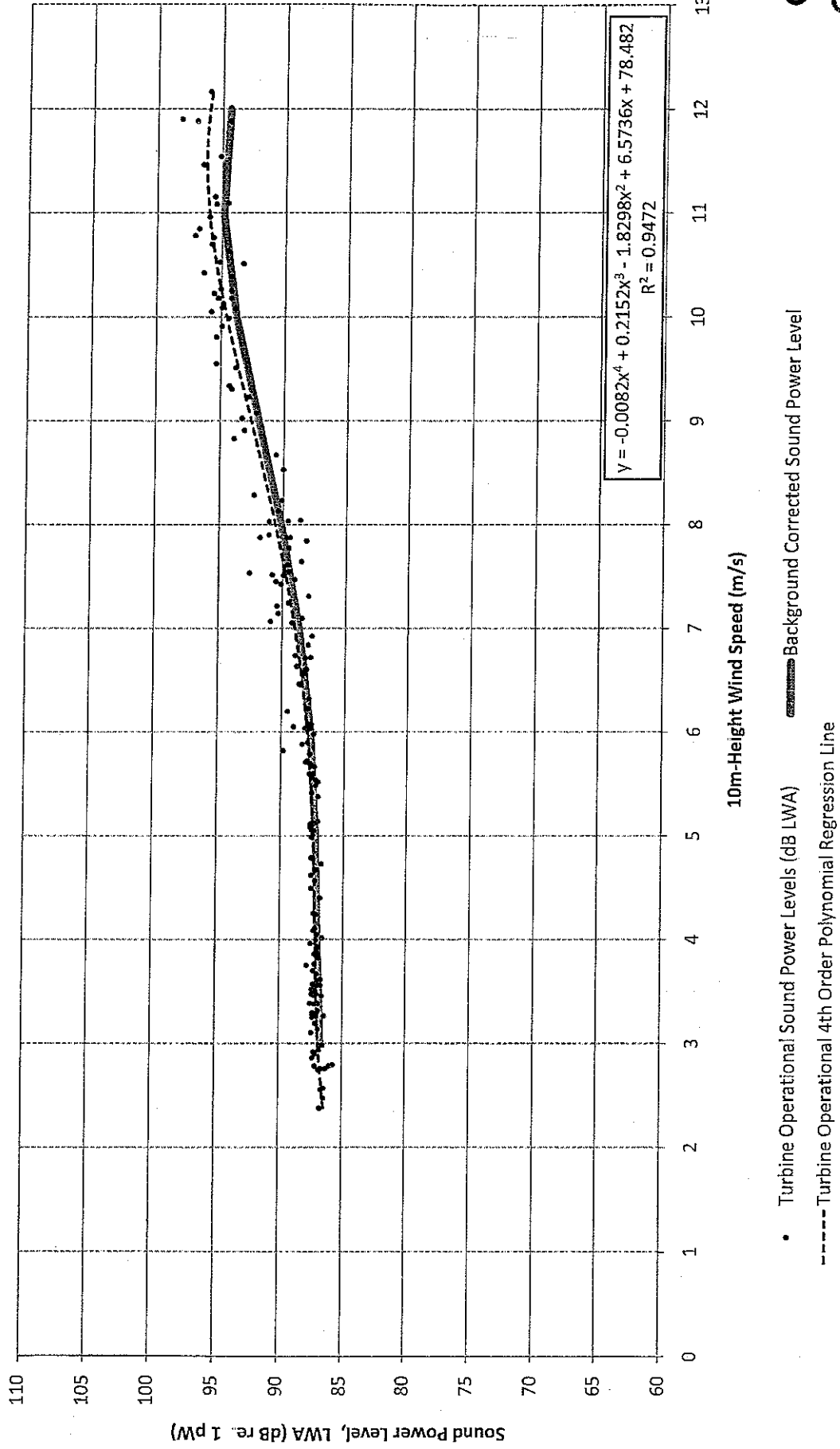


Appendix E

Calculation of Sound Power Level

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Endurance E-3120 - Noise Measurements
Calculated Sound Power Levels
1st and 2nd February 2011



Appendix F

Measured One Third Octave Levels

HM:2300/R.1

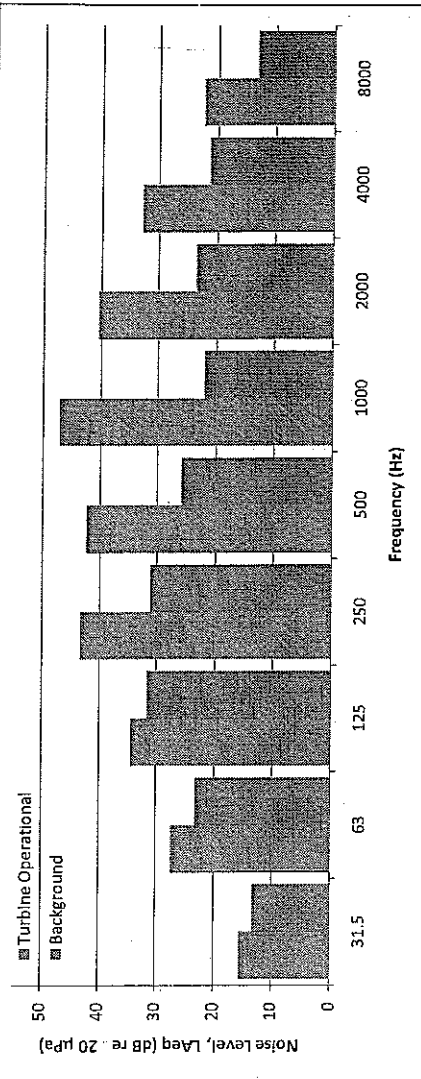
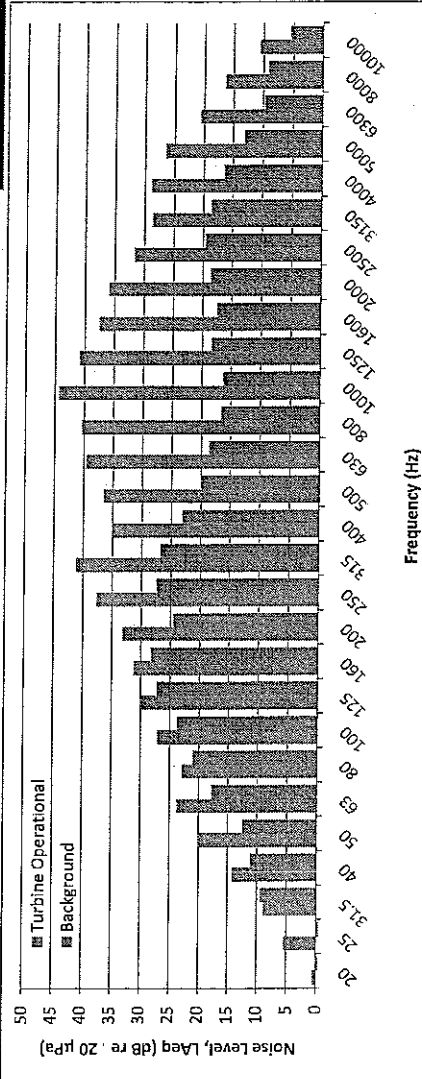
Endurance E-3120 Wind Turbine

Wind Speed - 3 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	0.6		-10.0	
25	5.4		-2.8	
31.5	8.8	15.7	9.4	13.5
40	14.2		11.1	
50	20.0		12.5	
63	23.7	27.2	17.8	23.1
80	22.8		21.0	
100	27.1	34.5	23.8	31.6
125	29.9		27.3	
160	31.3		28.3	
200	33.2		24.5	
250	37.6	43.2	27.4	31.2
315	41.2		26.8	
400	35.1	42.3	23.1	25.7
500	36.5		19.9	
630	39.6		18.6	
800	40.3		16.6	
1000	44.3	47.0	16.3	22.0
1250	40.9		18.4	
1600	37.6		17.5	
2000	36.0	40.5	18.6	23.4
2500	31.6		19.6	
3150	28.7		18.7	
4000	28.9	32.9	16.4	21.4
5000	26.5		13.1	
6300	20.6		9.8	
8000	16.4	22.3	9.2	13.3
10000	10.7		5.5	

Overall	50.2	35.9
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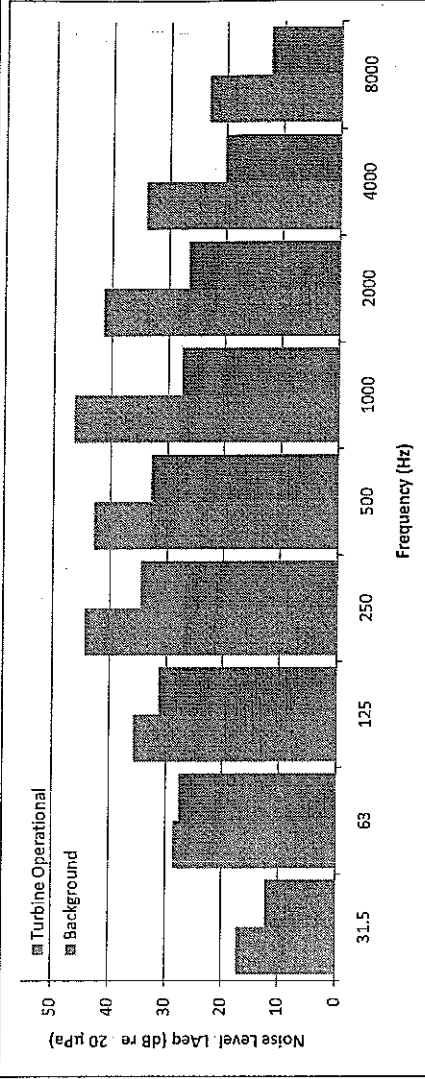
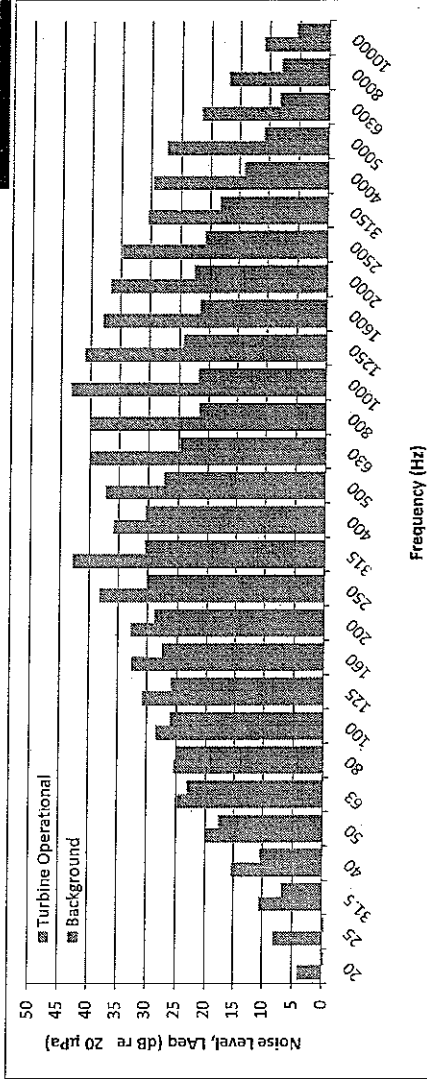
HM:2300/R1

Endurance E-3120 Wind Turbine Wind Speed - 4 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	4.2		-9.0	
25	8.1		-1.1	
31.5	10.6	17.2	6.8	12.2
40	15.4		10.5	
50	19.8		17.6	
63	24.7	28.7	23.1	27.6
80	25.4		25.0	
100	28.5		26.1	
125	30.8	35.7	25.9	31.3
160	32.6		27.4	
200	32.7		28.8	
250	38.2	44.4	30.1	34.6
315	42.8		30.5	
400	35.9		30.4	
500	37.2	42.8	27.3	32.9
630	40.0		24.8	
800	40.1		21.6	
1000	43.3	46.4	21.7	27.5
1250	41.0		24.3	
1600	38.0		21.5	
2000	36.7	41.5	22.6	26.5
2500	34.8		20.8	
3150	30.4		18.3	
4000	29.6	34.1	14.1	20.2
5000	27.3		10.8	
6300	21.5		8.3	
8000	17.0	23.1	8.0	12.2
10000	11.0		5.5	

Overall	50.5	39.0
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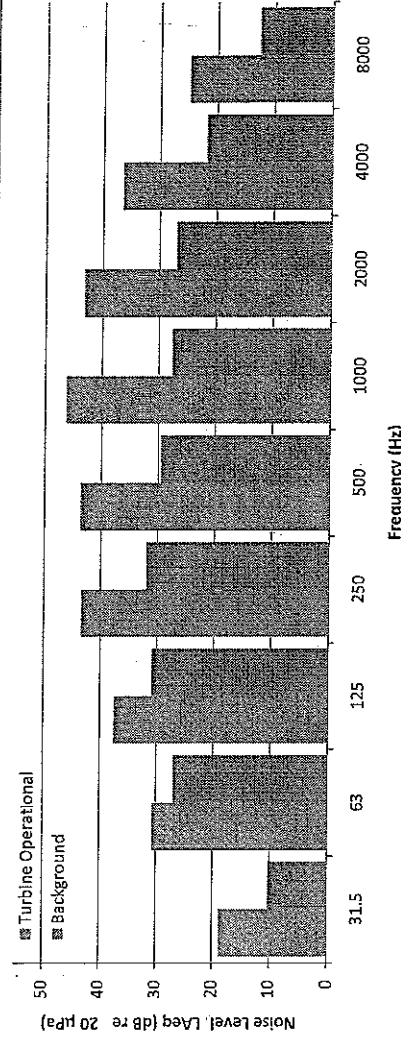
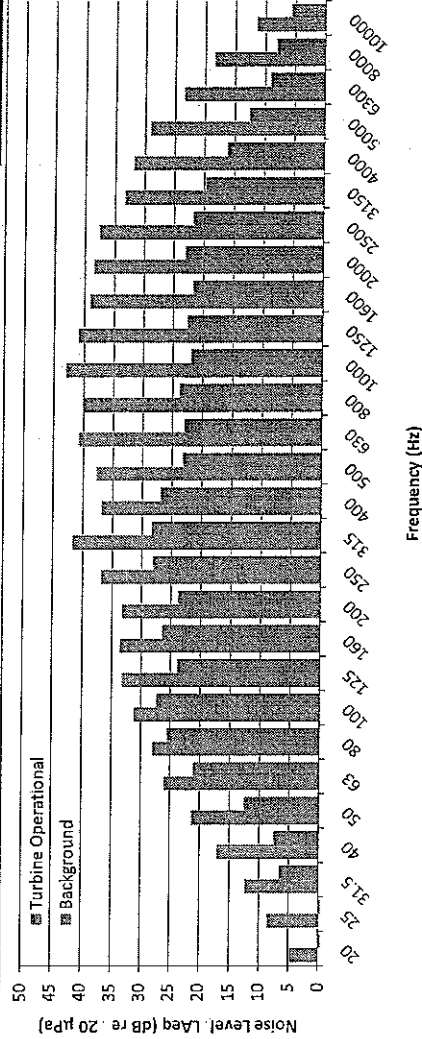
HM:2300/R1

Endurance E-3120 Wind Turbine Wind Speed - 5 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	4.8		-10.8	
25	8.5		-4.6	
31.5	12.4	18.8	6.6	10.2
40	17.1		7.5	
50	21.3		12.6	
63	26.0	30.6	21.0	27.0
80	27.9		25.5	
100	31.2		27.3	
125	33.2	37.6	23.9	30.9
160	33.6		26.4	
200	33.4		23.8	
250	36.9	43.4	28.1	32.0
315	41.7		28.4	
400	36.9		26.9	
500	37.7	43.6	23.1	29.5
630	40.8		22.9	
800	40.1		23.8	
1000	43.0	46.3	22.0	27.6
1250	41.0		22.6	
1600	39.0		21.7	
2000	38.4	43.2	22.9	27.0
2500	37.7		21.8	
3150	33.3		19.6	
4000	31.9	36.5	16.2	21.8
5000	29.0		12.6	
6300	23.4		9.1	
8000	18.5	24.8	8.1	12.6
10000	11.5		5.6	

Overall	50.8	37.4
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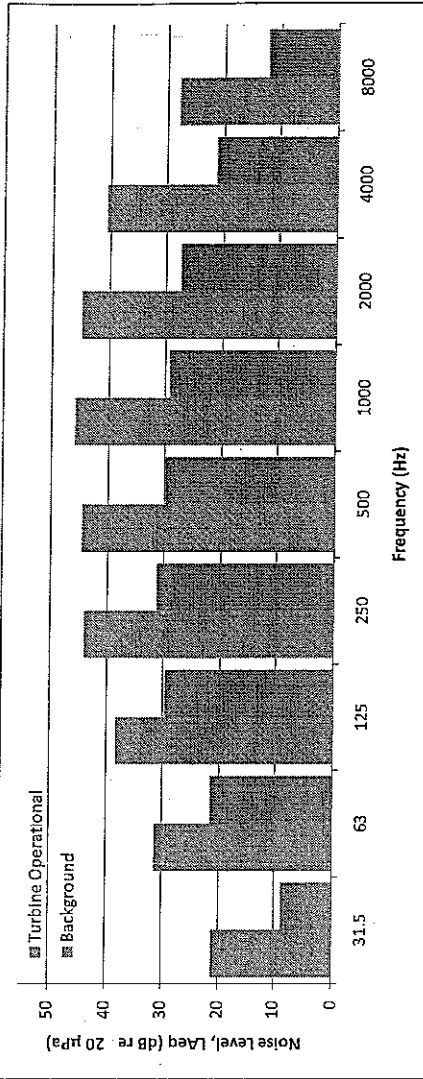
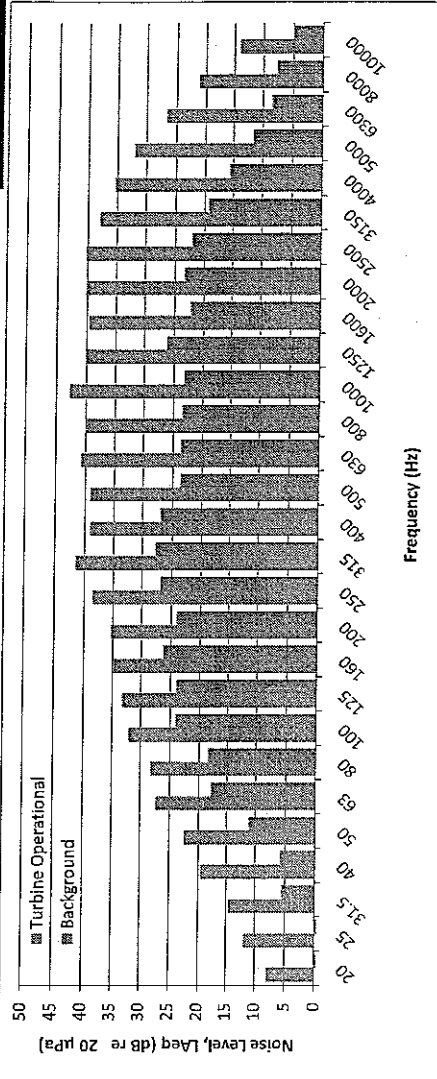
HM:2300/R/1

Endurance E-3120 Wind Turbine Wind Speed - 6 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	8.0		-12.7	
25	11.9		-6.5	
31.5	14.6	21.3	5.5	8.8
40	19.5		5.8	
50	22.4		11.2	
63	27.3	31.4	17.8	21.5
80	28.2		18.3	
100	32.1		24.0	
125	33.3	38.3	24.0	29.6
160	34.8		26.2	
200	35.3		24.0	
250	38.5	43.9	26.8	31.2
315	41.5		27.7	
400	39.1		27.0	
500	39.1	44.5	23.7	29.8
630	40.8		23.6	
800	39.8		23.5	
1000	42.8	45.9	23.2	29.3
1250	40.1		26.2	
1600	39.7		22.2	
2000	40.2	44.8	23.3	27.3
2500	40.3		22.1	
3150	38.0		19.3	
4000	35.3	40.5	15.6	21.3
5000	32.0		11.6	
6300	26.6		8.5	
8000	21.1	27.9	7.7	12.1
10000	14.1		5.0	

Overall	51.5	36.9
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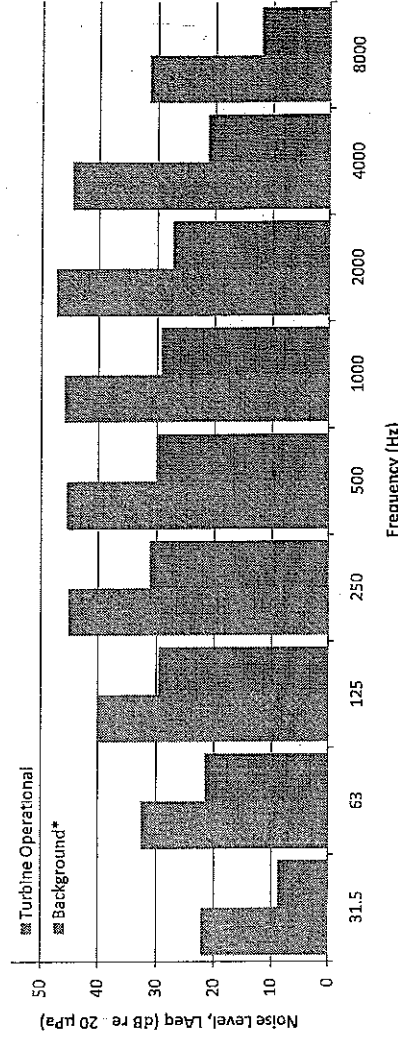
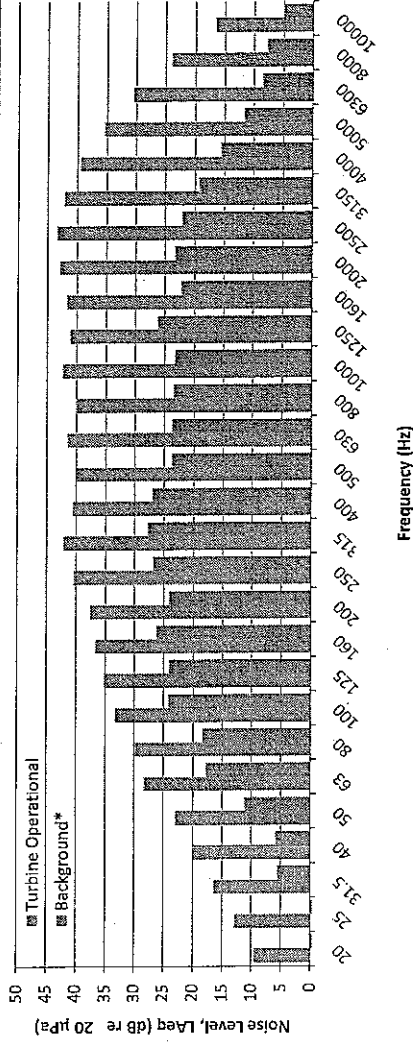
Endurance E-3120 Wind Turbine
Wind Speed - 7 m/s



Frequency (Hz)	Turbine Operational		Background*	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	9.4		-12.7	
25	12.9		-6.5	
31.5	16.5	22.2	5.5	8.8
40	20.1		5.8	
50	22.9		11.2	
63	28.3	32.6	17.8	21.5
80	29.8		18.3	
100	33.3		24.0	
125	35.2	40.0	24.0	29.6
160	36.7		26.2	
200	37.7		24.0	
250	40.4	45.2	26.8	31.2
315	42.1		27.7	
400	40.6		27.0	
500	40.0	45.5	23.7	29.8
630	41.5		23.6	
800	39.9		23.5	
1000	42.4	46.0	23.2	29.3
1250	41.1		26.2	
1600	41.6		22.2	
2000	42.9	47.5	23.3	27.3
2500	43.4		22.1	
3150	42.2		19.3	
4000	39.5	44.6	15.6	21.3
5000	35.4		11.6	
6300	30.5		8.5	
8000	24.0	31.5	7.7	12.1
10000	16.6		5.0	

Overall	53.2	36.9
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*Background taken from 5m/s



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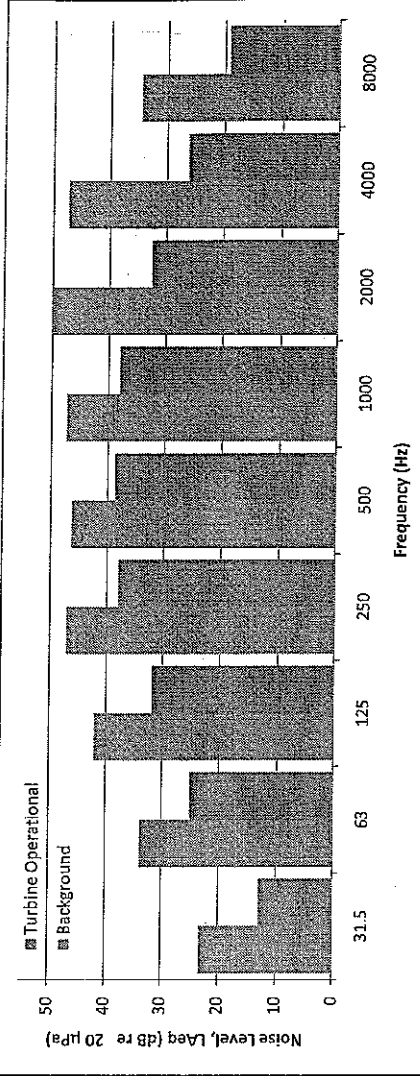
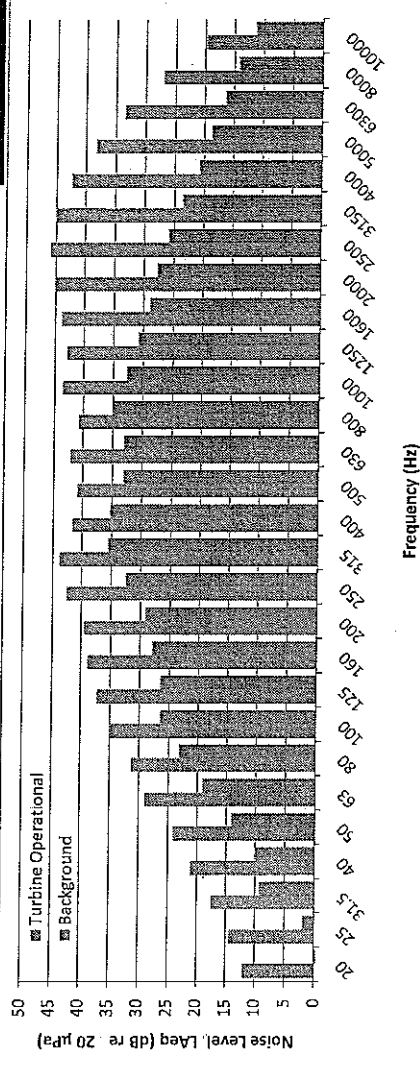
HM-2300/R1

Endurance E-3120 Wind Turbine
Wind Speed - 8 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	12.1		-1.9	
25	14.5		2.0	
31.5	17.5	23.2	9.3	13.0
40	21.0		10.0	
50	24.1		14.1	
63	29.0	33.8	19.1	25.0
80	31.3		23.2	
100	35.0		26.5	
125	37.2	42.0	27.9	31.8
160	38.8			
200	39.5		29.2	
250	42.5	47.1	32.5	37.9
315	43.8		35.5	
400	41.6		35.3	
500	40.9	46.3	33.1	38.7
630	42.1		33.1	
800	40.7		35.0	
1000	43.6	47.3	32.7	38.0
1250	42.9		30.8	
1600	43.8		28.9	
2000	45.1	49.8	27.8	32.5
2500	45.9		25.9	
3150	45.0		23.6	
4000	42.3	47.4	20.7	26.2
5000	38.3		18.7	
6300	33.5		16.4	
8000	27.0	34.5	14.2	19.2
10000	19.7		11.3	

Overall	55.1	43.8
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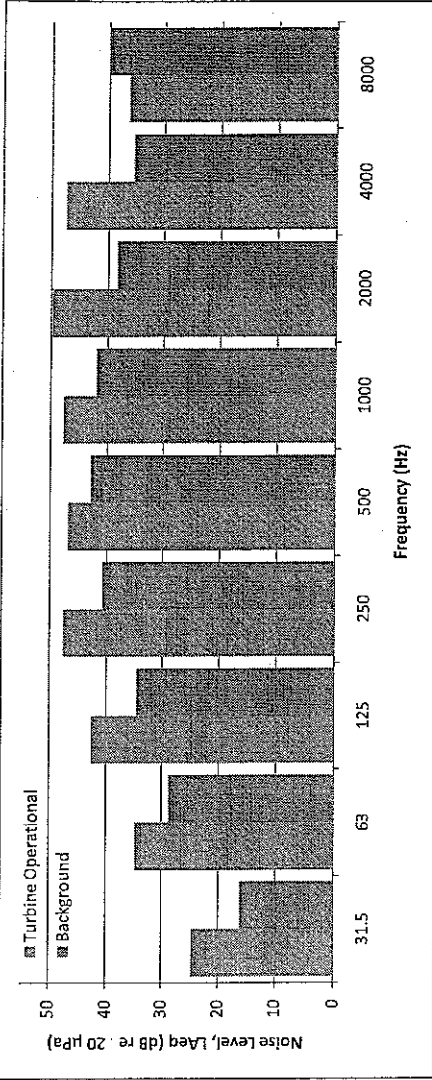
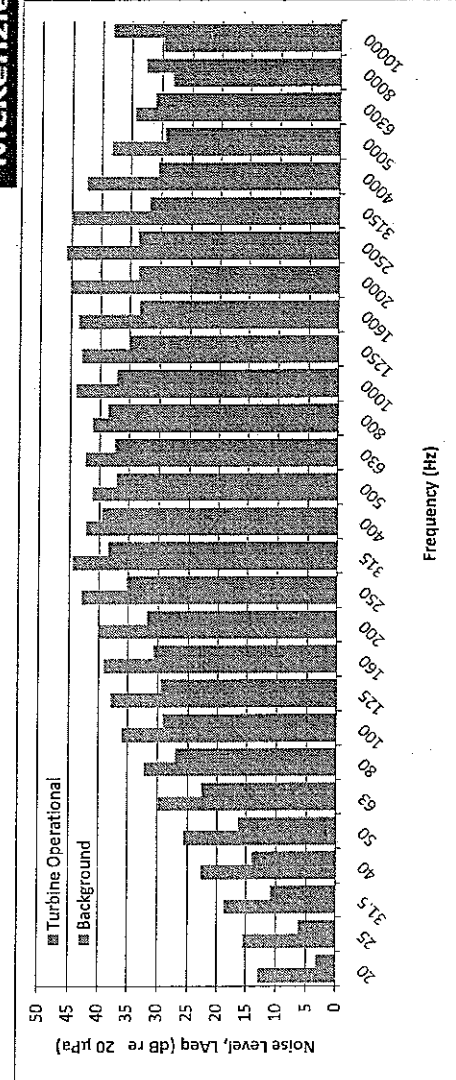


HM:2300/R1

Endurance E-3120 Wind Turbine Wind Speed - 9 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB (A))	1/3 Octave Band (dB(A))	Octave Band (dB (A))
20	12.9		3.3	
25	15.5		6.3	
31.5	18.7	24.7	10.9	16.2
40	22.7		14.0	
50	25.7		16.3	
63	29.8	34.8	22.6	28.7
80	32.2		27.1	
100	35.9		29.1	
125	37.8	42.6	29.5	34.6
160	39.1		30.6	
200	40.0		31.9	
250	42.9	47.6	35.2	40.8
315	44.5		38.5	
400	42.3		39.5	
500	41.2	46.8	37.1	42.9
630	42.5		37.4	
800	41.2		38.6	
1000	44.1	47.7	37.1	41.9
1250	43.2		35.1	
1600	43.7		33.4	
2000	45.1	49.7	33.6	38.4
2500	45.8		33.7	
3150	44.9		31.9	
4000	42.5	47.5	30.5	35.5
5000	38.3		29.4	
6300	34.3		31.0	
8000	28.2	36.4	32.6	39.8
10000	29.8		38.1	
Overall	55.3		48.5	



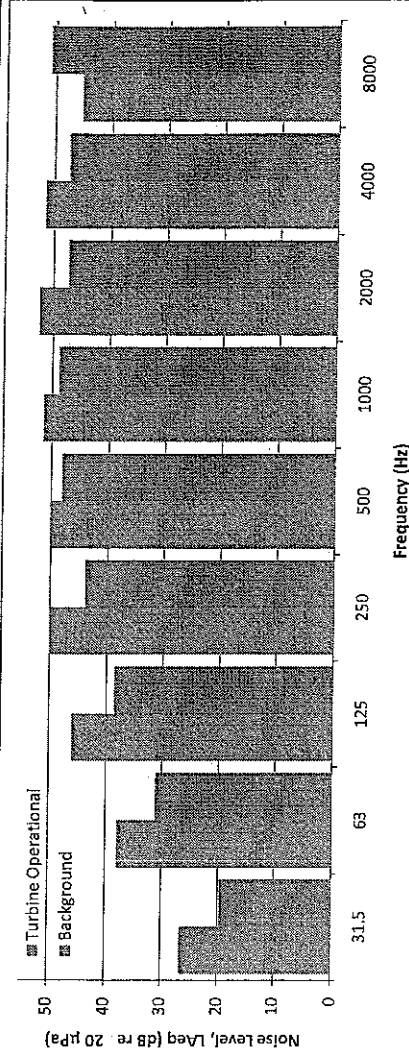
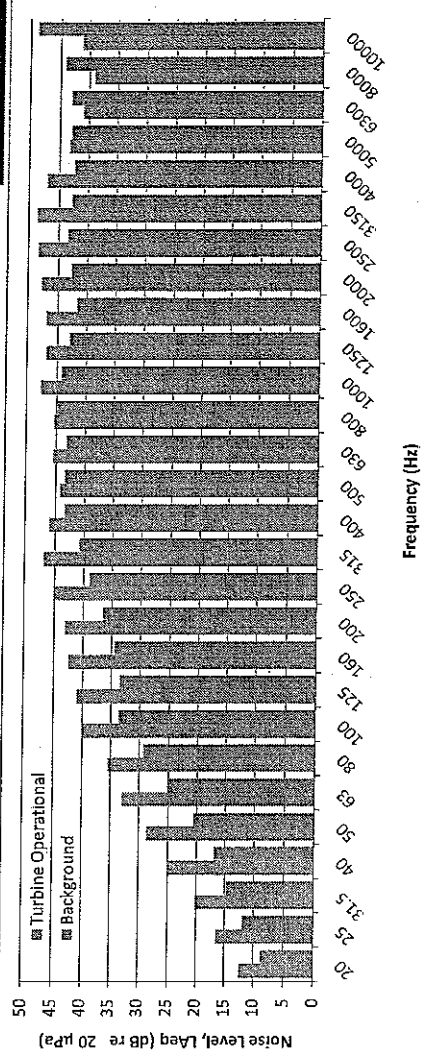
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Endurance E-3120 Wind Turbine Wind Speed - 10 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	12.5		8.8	
25	16.4		11.9	
31.5	20.1	26.7	14.7	19.8
40	25.1		16.9	
50	28.7		20.5	
63	32.9	37.9	25.2	31.1
80	35.4		29.3	
100	40.0		33.6	
125	41.0	46.0	33.4	38.6
160	42.4		34.5	
200	43.1		36.5	
250	45.2	50.1	38.9	43.9
315	46.8		40.9	
400	46.0		43.4	
500	44.2	50.1	43.5	48.1
630	45.5		43.2	
800	45.4		44.8	
1000	47.7	51.5	44.2	48.8
1250	46.8		42.9	
1600	46.8		41.7	
2000	47.7	52.4	42.7	47.4
2500	48.4		43.4	
3150	48.5		42.7	
4000	47.0	51.5	42.4	47.5
5000	43.2		42.9	
6300	41.0		43.0	
8000	39.1	45.3	44.2	50.9
10000	41.2		48.8	

Overall	58.7	56.1
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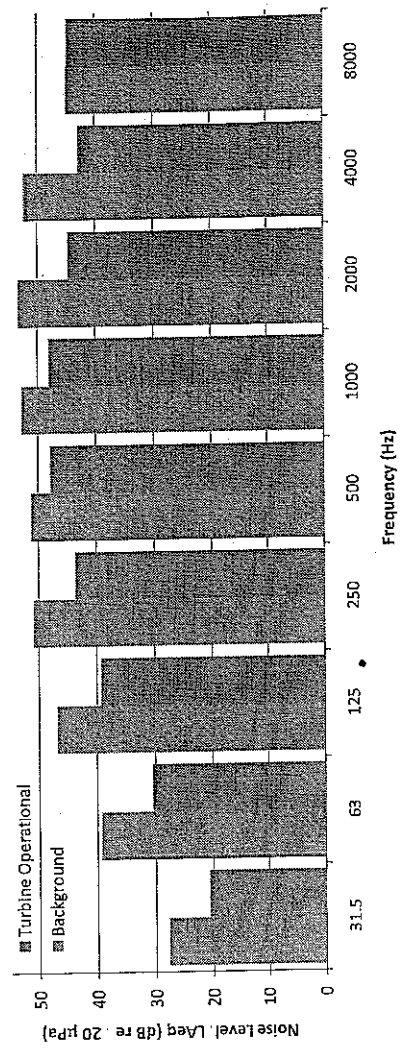
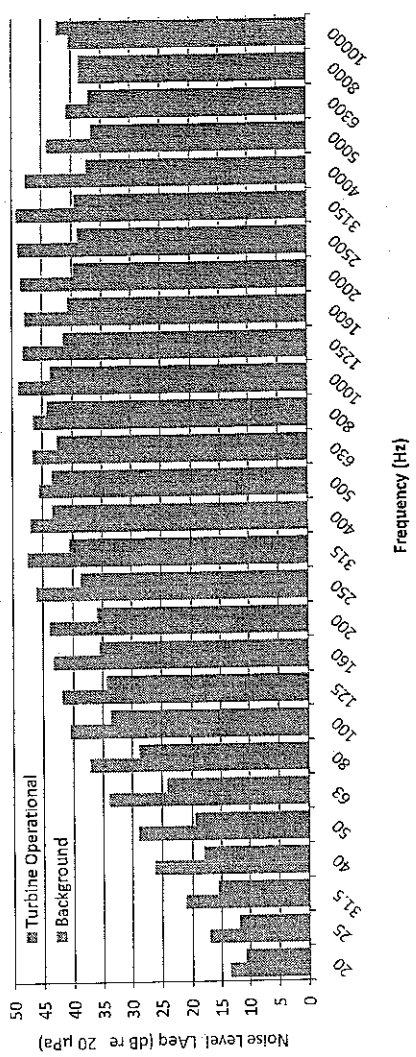
HM:2500/R1

Endurance E-3120 Wind Turbine Wind Speed - 11 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	13.5		10.7	
25	17.1		11.9	
31.5	21.0	27.7	15.6	20.6
40	26.1		18.0	
50	28.9		19.5	
63	33.9	39.3	24.1	30.4
80	37.2		28.8	
100	40.5		33.6	
125	41.8	46.8	34.3	39.3
160	43.2		35.4	
200	43.9		35.9	
250	46.0	50.8	38.7	43.5
315	47.5		40.5	
400	47.0		43.3	
500	45.6	51.2	43.3	47.8
630	46.5		42.5	
800	46.4		44.2	
1000	49.0	52.8	43.5	48.0
1250	48.2		41.4	
1600	47.9		40.7	
2000	48.6	53.3	39.7	44.6
2500	49.1		38.9	
3150	49.3		39.5	
4000	47.7	52.3	37.4	42.8
5000	44.1		36.6	
6300	40.8		37.1	
8000	38.7	44.8	38.7	44.7
10000	40.4		42.4	

Overall	59.6	53.7
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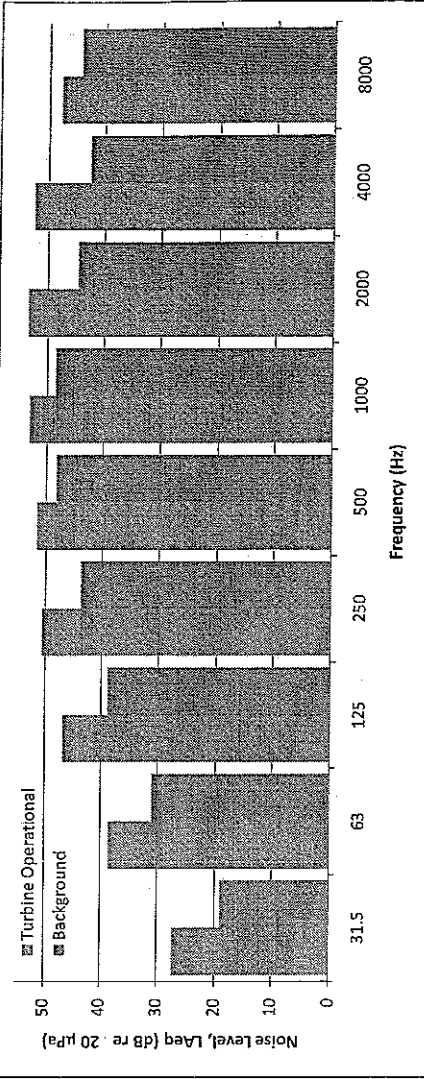
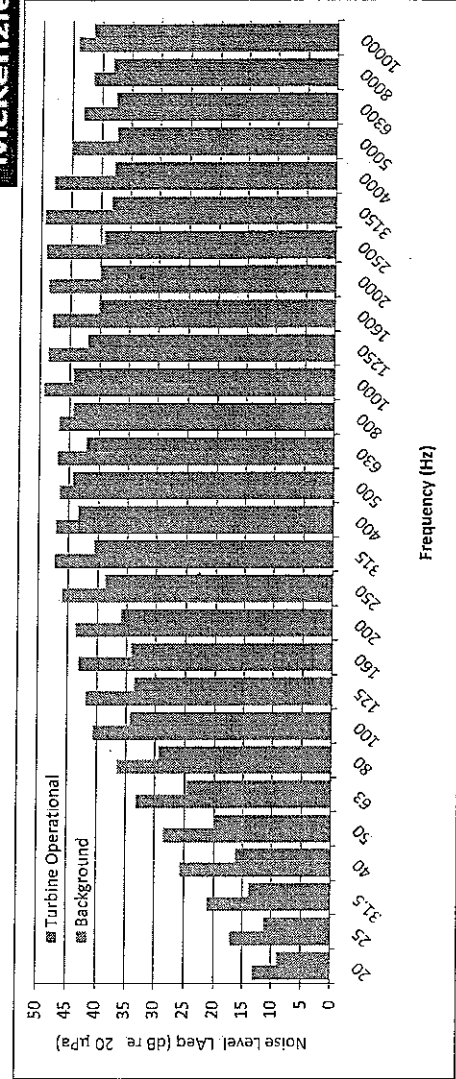
HM:2300/R1

Endurance E-3120 Wind Turbine Wind Speed - 12 m/s



Frequency (Hz)	Turbine Operational		Background	
	1/3 Octave Band (dB(A))	Octave Band (dB(A))	1/3 Octave Band (dB(A))	Octave Band (dB(A))
20	13.2		9.0	
25	17.2		11.3	
31.5	21.1	27.4	13.9	19.1
40	25.7		16.3	
50	28.4		20.0	
63	33.2	38.5	24.5	30.9
80	36.4		29.3	
100	40.6		34.4	
125	41.9	46.7	33.6	38.8
160	43.1		34.1	
200	43.7		36.0	
250	45.9	50.6	38.8	43.6
315	47.3		40.6	
400	47.0		43.4	
500	46.5	51.6	44.4	48.1
630	46.9		42.0	
800	46.7		44.4	
1000	49.3	53.1	44.4	48.5
1250	48.7		42.0	
1600	48.0		40.2	
2000	48.7	53.4	39.9	44.6
2500	49.2		39.4	
3150	49.4		38.2	
4000	47.9	52.5	37.8	42.6
5000	44.9		37.4	
6300	43.1		37.6	
8000	41.5	47.8	38.2	44.3
10000	44.1		41.5	

Overall	59.9	53.8
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Appendix G
Background Corrected One Third Octave Sound
Power Levels

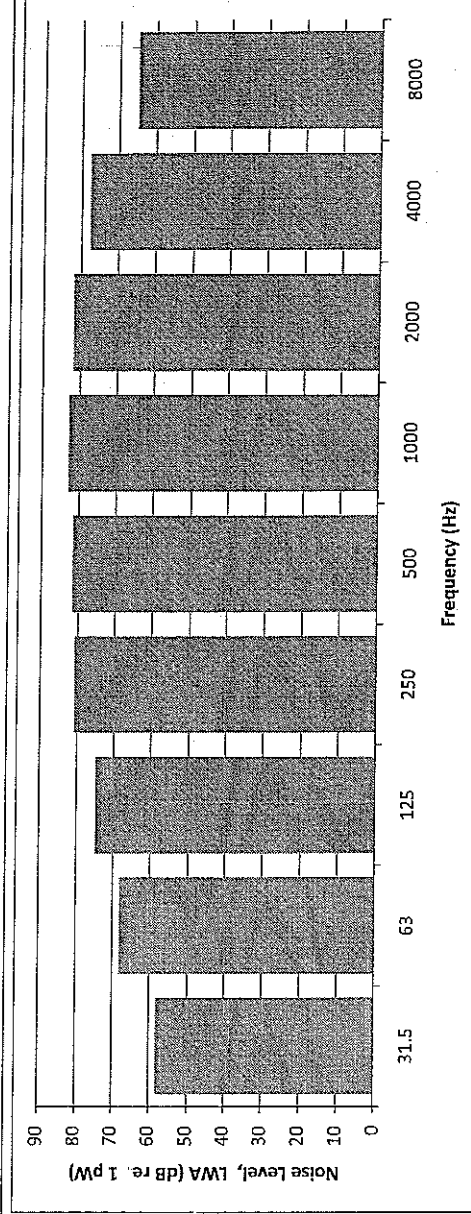
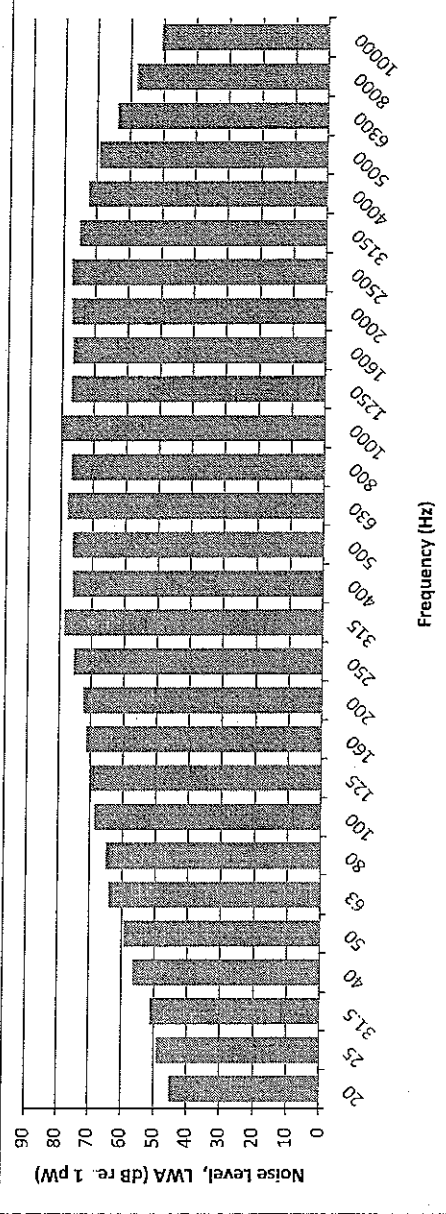
HM:2300/R1

Endurance E-3120 Wind Turbine Wind Speed - 6 m/s



Frequency (Hz)	1/3 Octave Band (dB LWA)	Octave Band (dB LWA)
20	45.1	
25	49.0	
31.5	51.1	58.1
40	56.4	
50	59.2	
63	63.9	68.0
80	64.9	
100	68.4	
125	69.9	74.8
160	71.3	
200	72.1	
250	75.3	80.8
315	78.4	
400	75.9	81.5
500	76.1	
630	77.8	
800	76.8	82.9
1000	79.8	
1250	77.1	
1600	76.7	81.9
2000	77.2	
2500	77.3	
3150	75.0	77.6
4000	72.4	
5000	69.1	
6300	63.7	64.9
8000	58.0	
10000	50.6	

Overall	88.5
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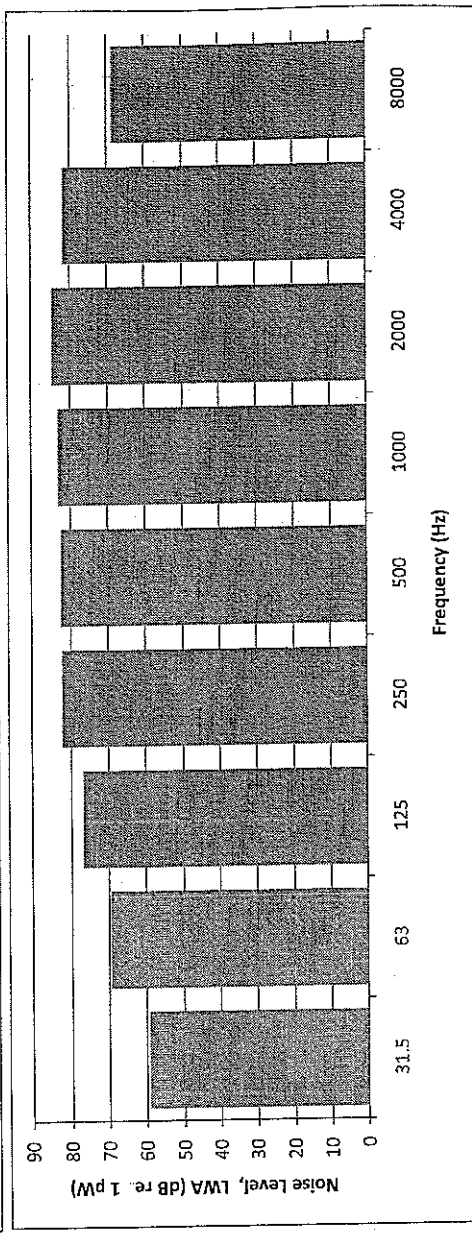
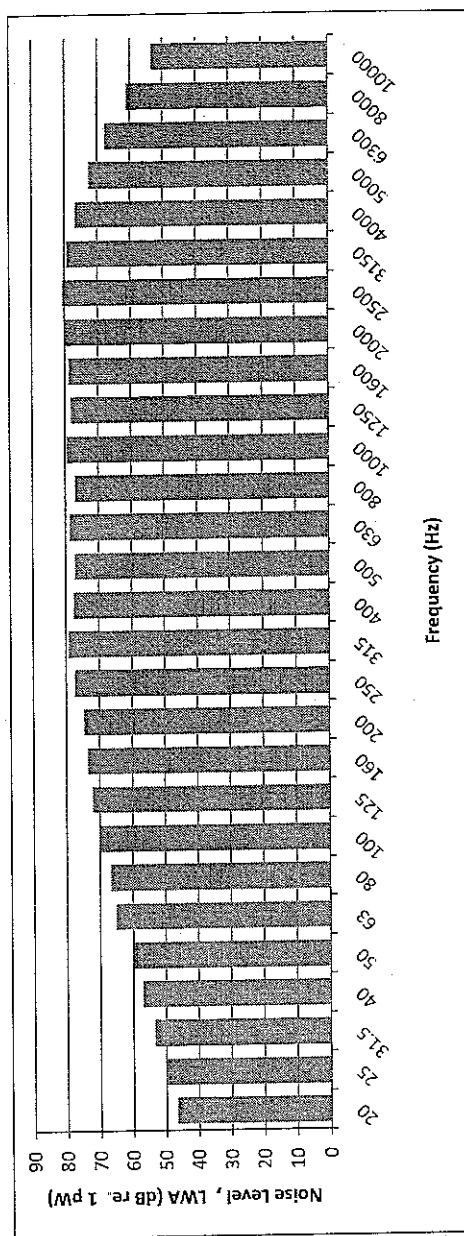
HM:2300/R1

Endurance E-3120 Wind Turbine Wind Speed - 7 m/s*



Frequency (Hz)	1/3 Octave Band (dB LWA)	Octave Band (dB LWA)
20	46.5	59.1
25	49.9	
31.5	53.2	
40	57.0	
50	59.7	69.4
63	65.0	
80	66.6	
100	69.9	
125	71.9	76.7
160	73.4	
200	74.6	
250	77.3	
315	79.1	82.1
400	77.5	
500	77.0	
630	78.6	
800	76.9	83.0
1000	79.4	
1250	78.1	
1600	78.7	
2000	80.0	84.5
2500	80.5	
3150	79.3	
4000	76.6	
5000	72.5	81.7
6300	67.6	
8000	61.0	
10000	53.4	
Overall		90.2

*Background taken from 6m/s

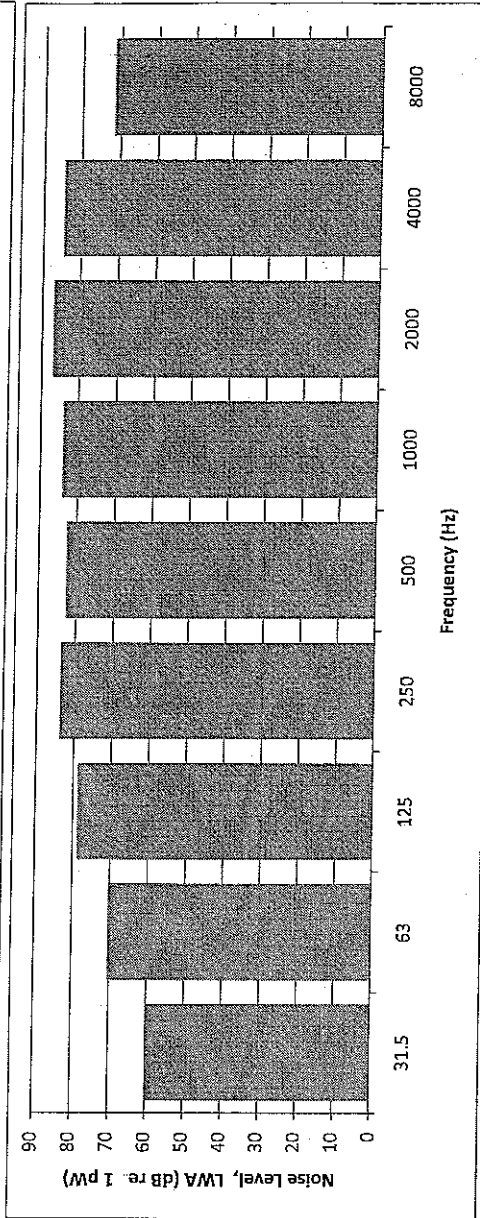
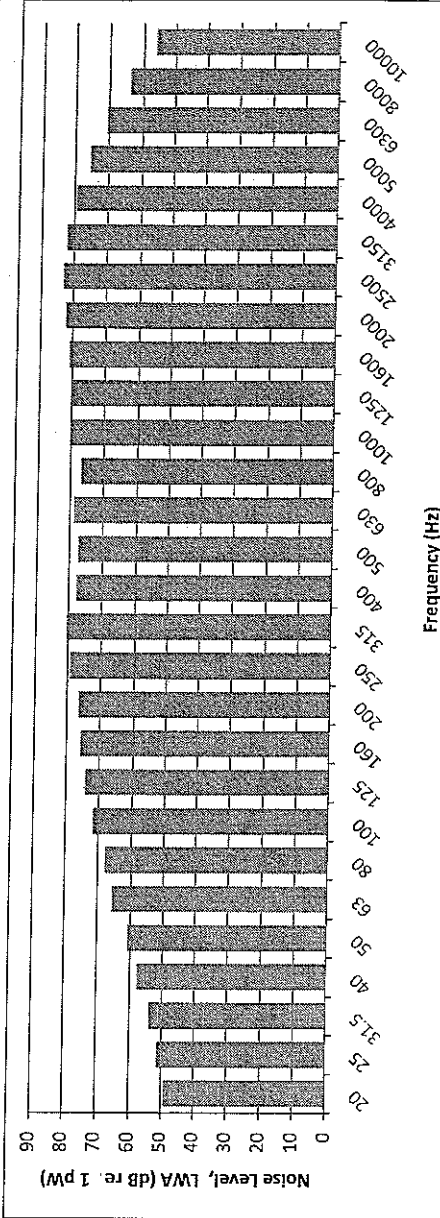


HM:2300/R1

Endurance E-3120 Wind Turbine Wind Speed - 8 m/s



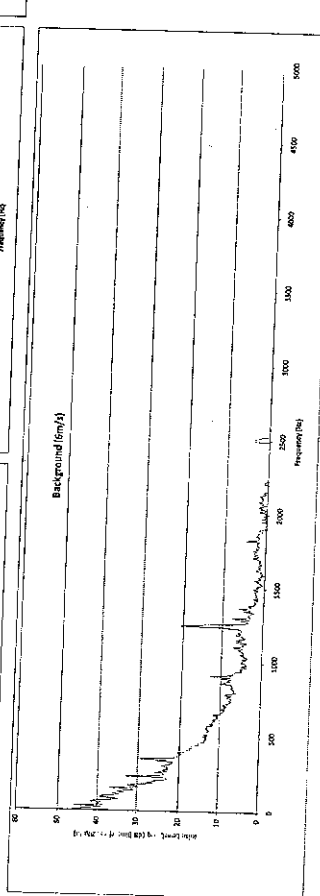
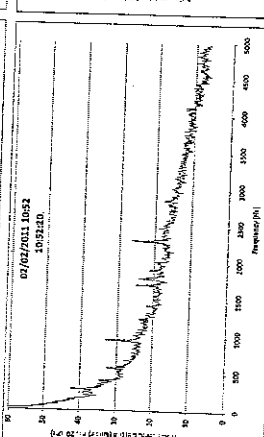
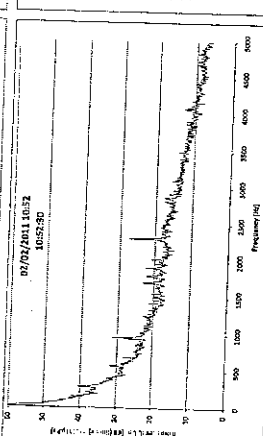
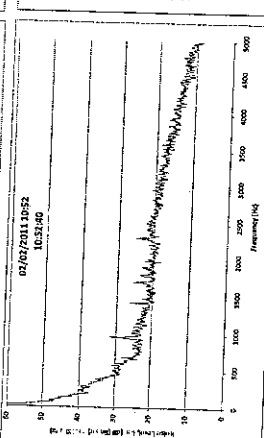
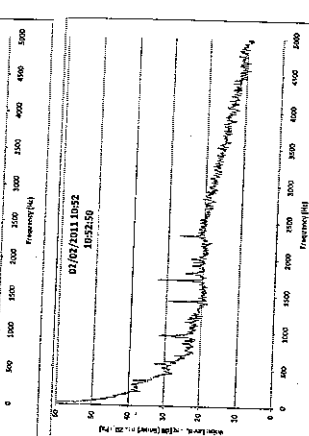
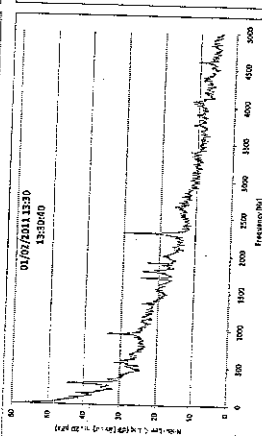
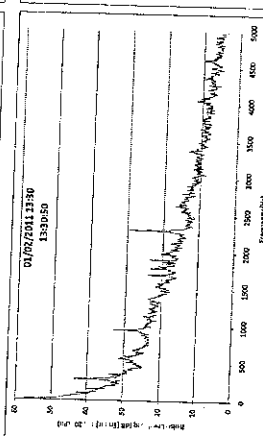
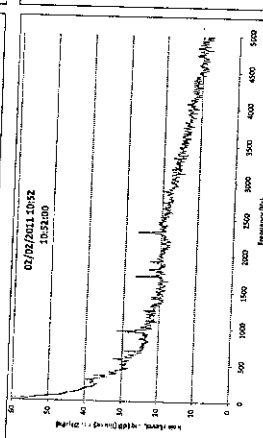
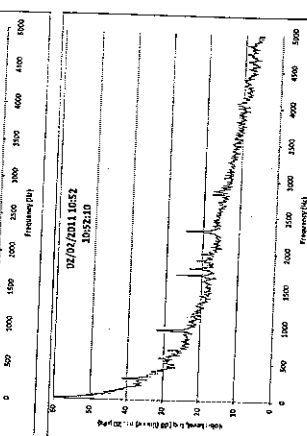
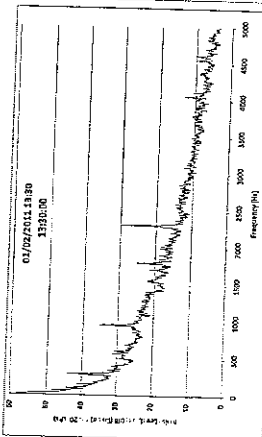
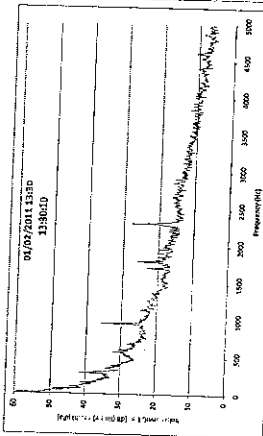
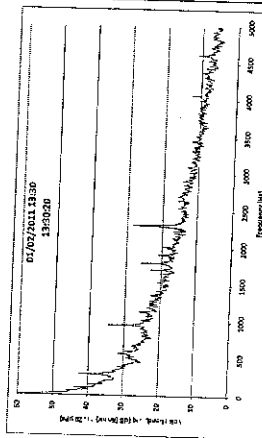
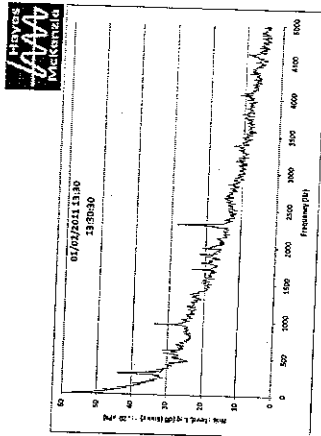
Frequency (Hz)	1/3 Octave Band (dB LWA)	Octave Band (dB LWA)
20	49.1	59.9
25	51.3	
31.5	53.9	
40	57.8	
50	60.7	70.3
63	65.6	
80	67.7	
100	71.4	
125	73.9	78.7
160	75.6	
200	76.2	
250	79.2	
315	80.3	83.7
400	77.6	
500	77.2	
630	78.6	
800	75.9*	83.9
1000	80.3	
1250	79.7	
1600	80.8	
2000	82.1	86.8
2500	83.0	
3150	82.1	
4000	79.4	
5000	75.3	84.5
6300	70.5	
8000	63.9	
10000	56.1	
Overall		91.8



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Appendix H

Narrowband Analysis

Endurance E-3120 - Narrowband Spectra
6m/s Wind SpeedHewlett
Packard

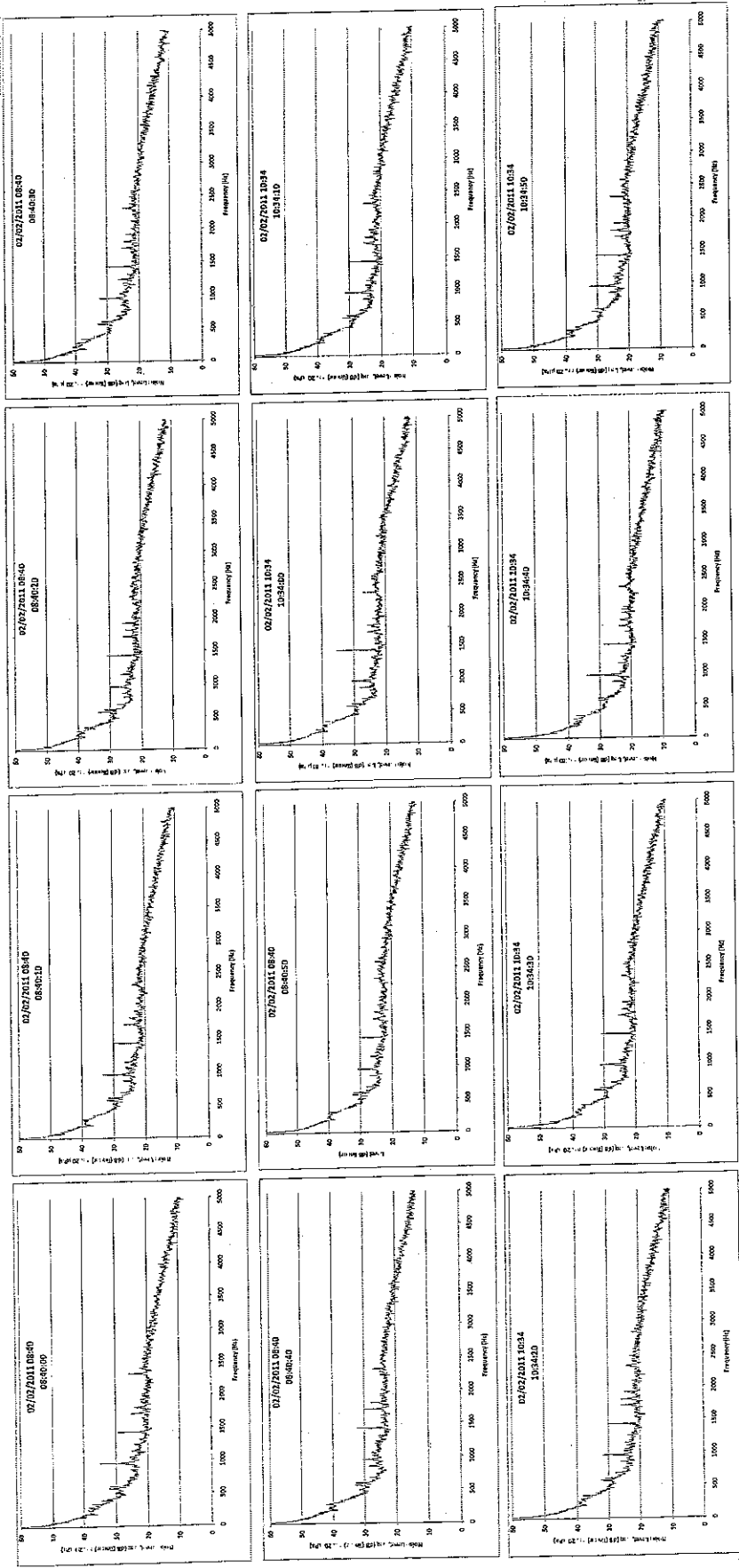
Results of total assessment

Frequency (Hz)	Total Audibility (dB)
287.2	-0.99
956.2	-2.08
2307.8	-0.01

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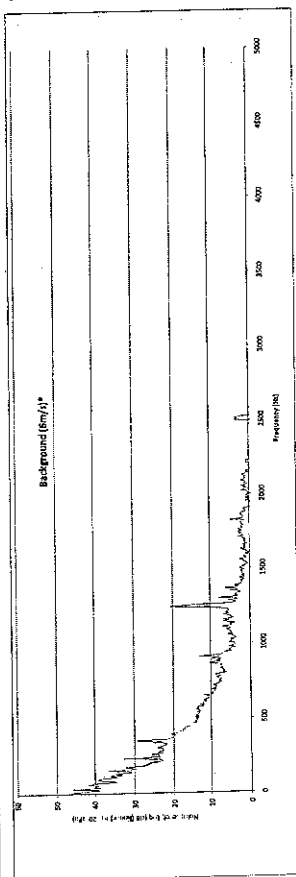
Endurance E-3120 - Narrowband Spectra
7m/s Wind Speed



No background noise data for 7m/s

Results of tonal assessment

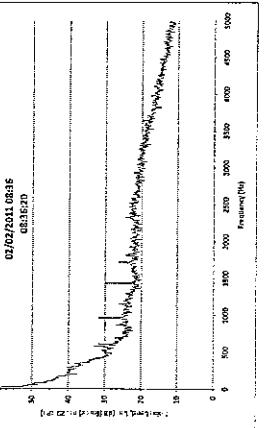
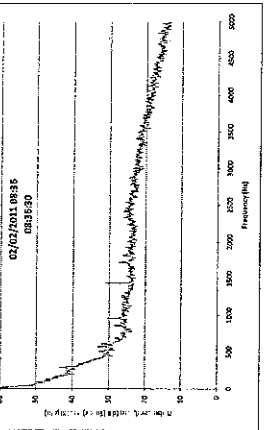
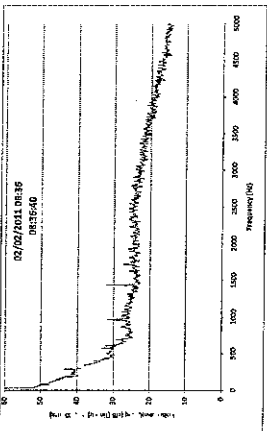
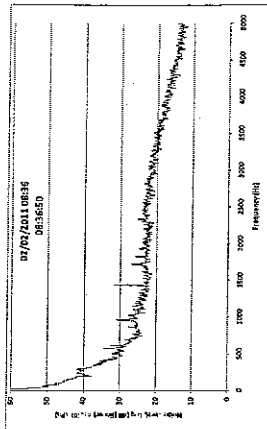
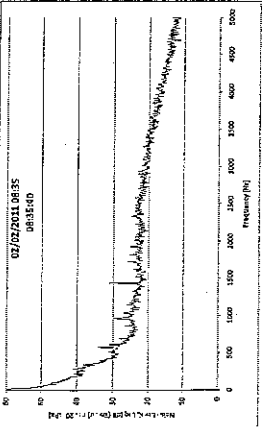
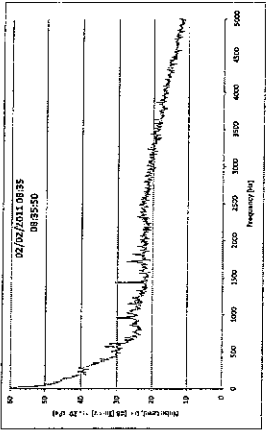
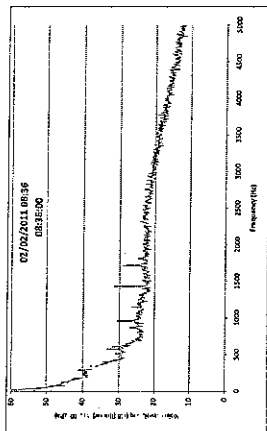
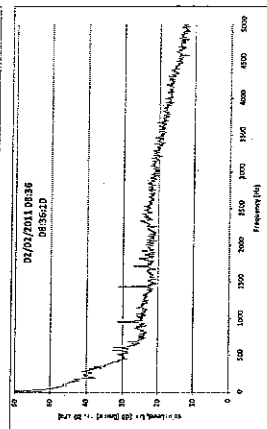
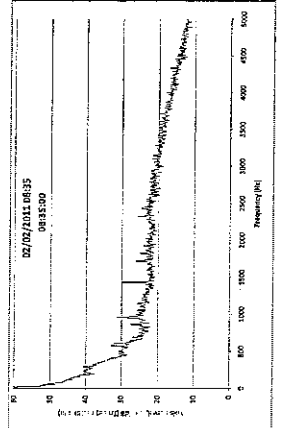
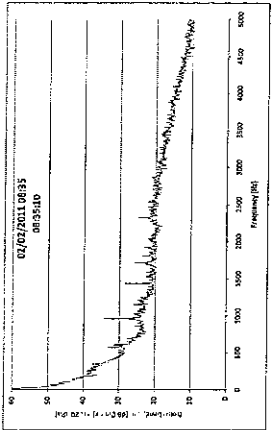
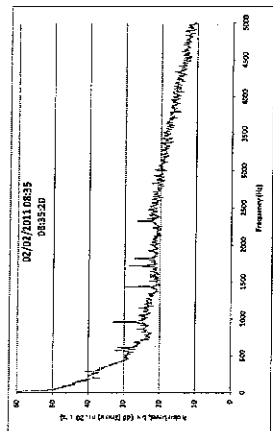
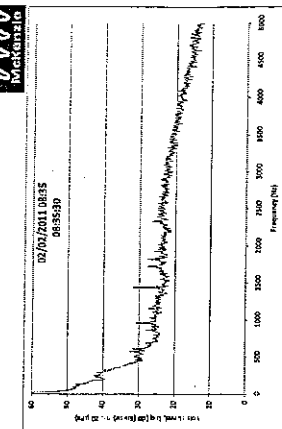
Frequency (Hz)	Tonal Amplitude (dB)
No tones identified	



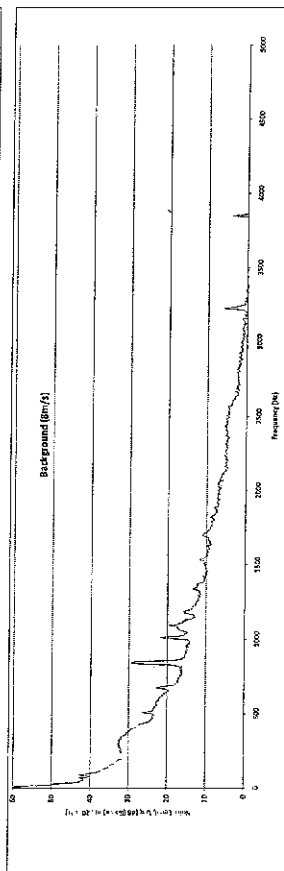
HM-2300/R1

Endurance E-3120 - Narrowband Spectra
3M's Wind Speed

NOISE
/AAA
MAGNITUDE



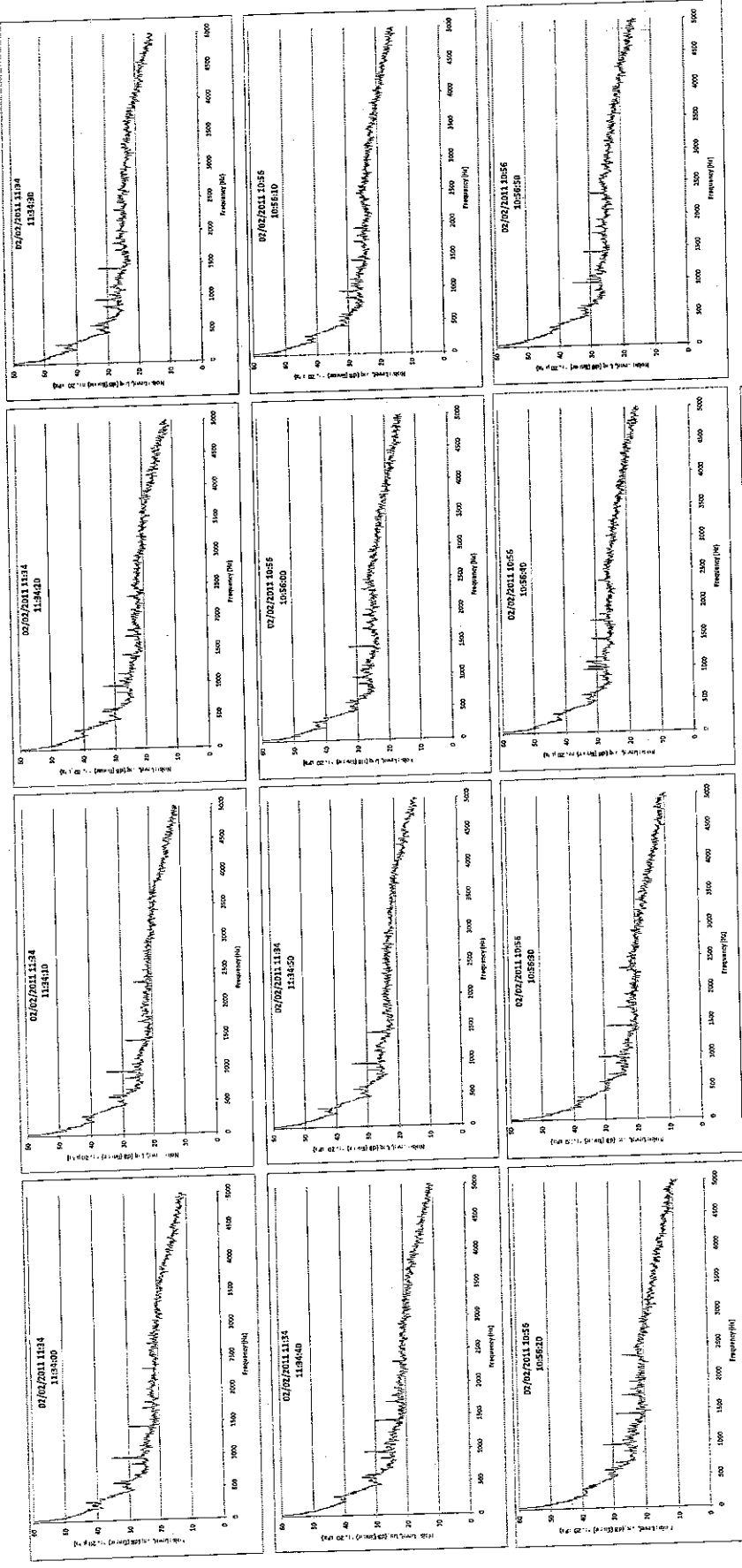
Results of tonal assessment
Frequency (Hz) | Tonal Audibility (dB)
No tones identified





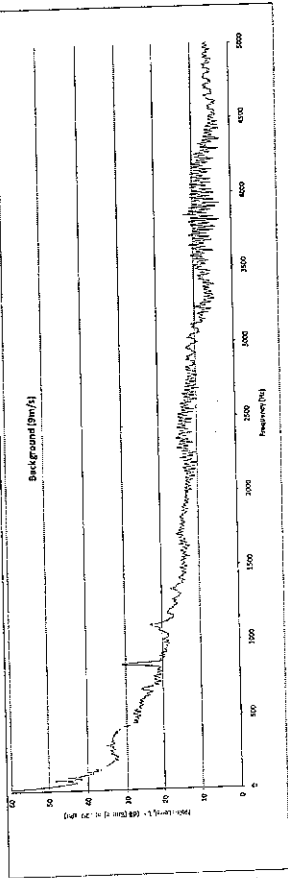
Endurance B-3120 - Narrowband Spectra
9m/s Wind Speed

HM-2300/R1



Result of tonal assessment

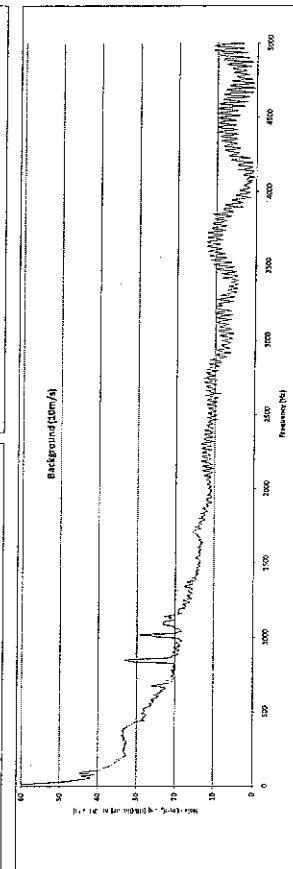
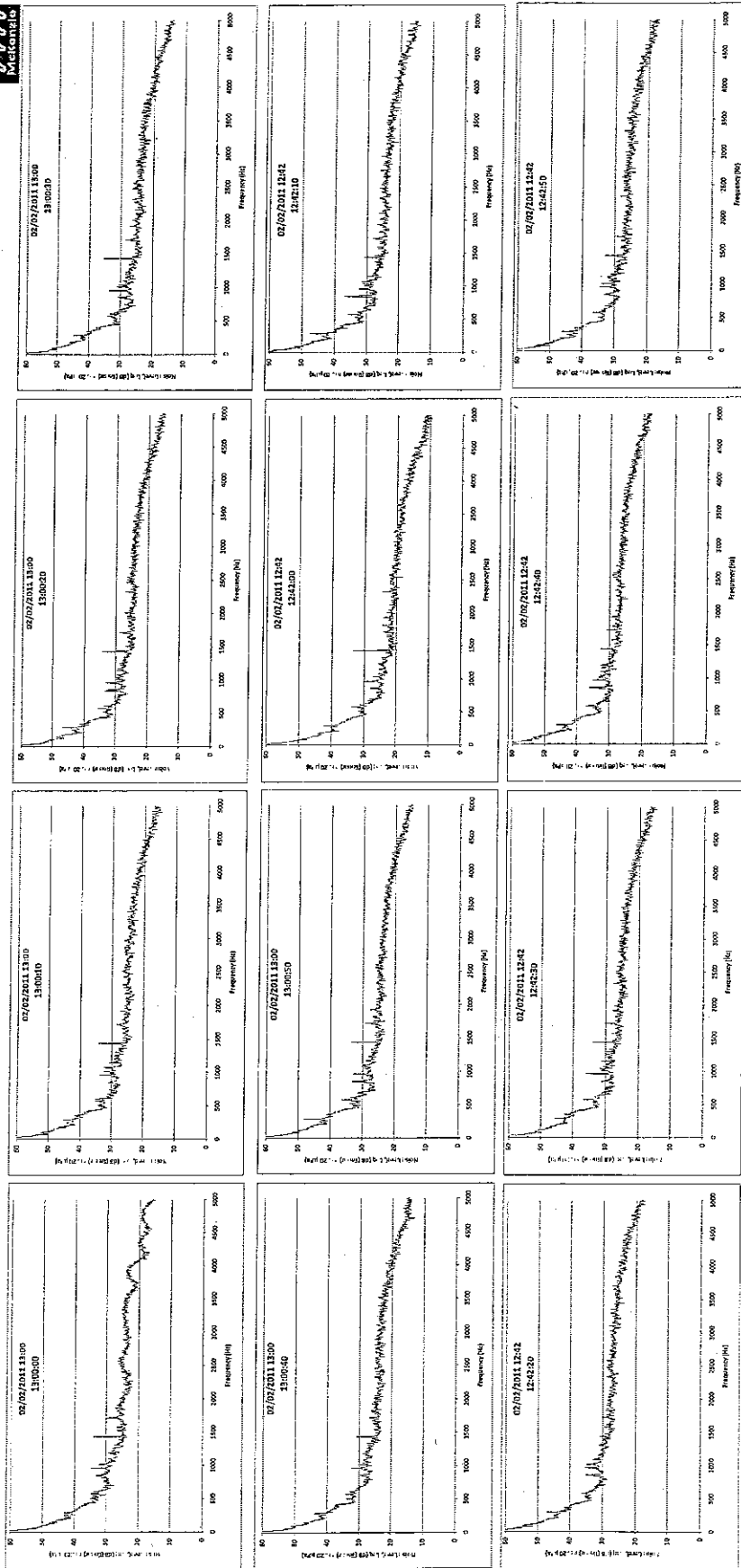
Frequency (Hz)	Tonal Audibility (dB)
No tones identified	



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Endurance E-3120 - Narrowband Spectra
10m's Wind Speed



Results of tonal assessment

Frequency (Hz)	Tonal Audibility (dB)
No tones identified	